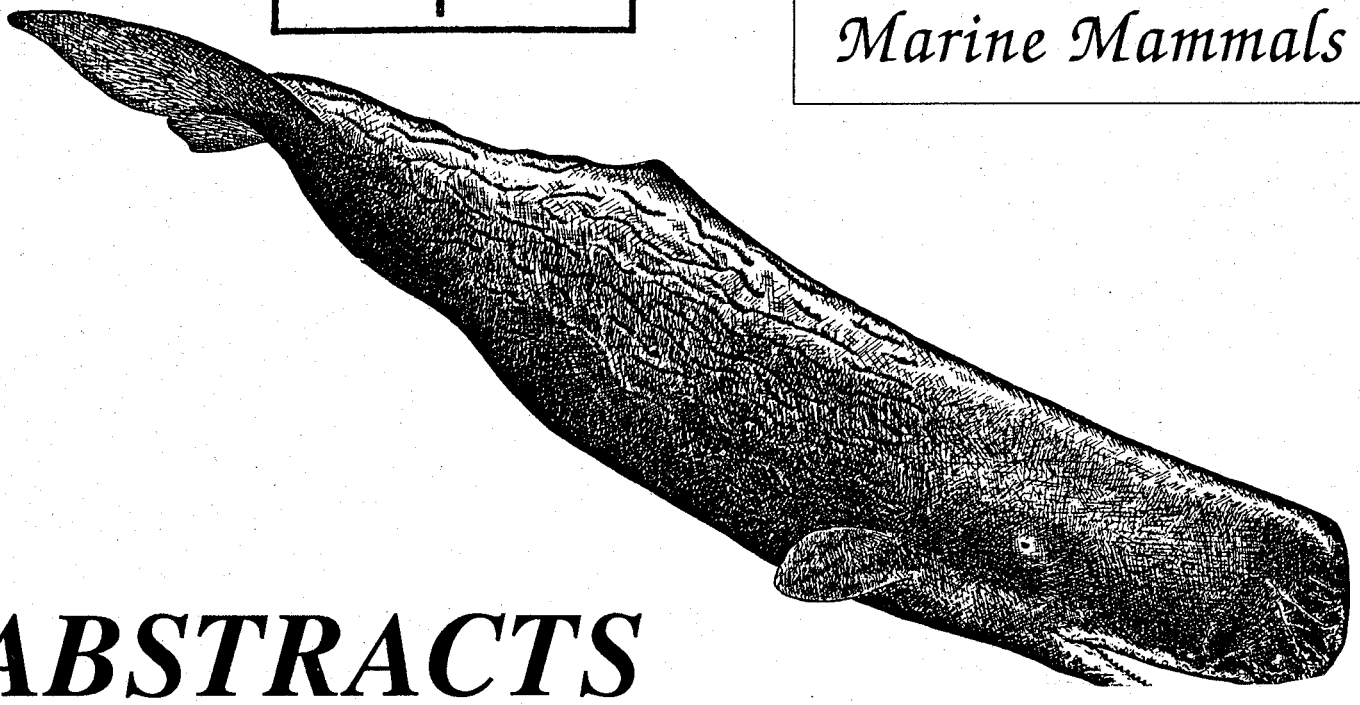
Tenth Biennial Conference on the Biology of Marine Mammals



ABSTRACTS

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SYMPOSIUM:
Cetacean Habitats

HABITAT DESCRIPTION FOR CETACEANS IN THE GULF OF MEXICO: A PRELIMINARY ANALYSIS

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We used visual sighting and hydro-acoustic data from six, seasonal ship and aerial surveys to characterize the preferred habitats of cetaceans along the continental slope (100 to 2000m isobaths) in the north-central and western Gulf of Mexico. Hydrographic data were simultaneously collected by CTD, XBTs and remote sensing. Data were analyzed using frequency plots, GIS mapping and canonical correspondence analysis. For this analysis, we focused on *Tursiops truncatus* (TT), *Stenella frontalis* (SF), *Stenella attenuata* (SA), and *Physeter macrocephalus* (PM). TT and SF sightings occurred in shallow water (84% < 200m) and seldom more than 30 km beyond the shelf break (100 m isobath). SA and PM sightings occurred in deeper water (95% > 500m) up to 240 km beyond the shelf break. PM and SA were associated with thermocline depth and thickness which was characteristic of mesoscale eddies. This study was funded in part by the Minerals Management Service under Contract No. 14-35-0001-30619 to Texas A&M Univ. and Interagency Agreement 16197 to the NMFS.

DISTRIBUTION, ABUNDANCE AND HABITAT ALLOCATION OF DOLPHINS IN THE PACAYA/SAMIRIA RESERVE, PERUVIAN AMAZON

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Vessel surveys were made during high-, mid-, and low-water seasons, 1991-1993, in the Samiria River, Peru, to determine distribution, density and habitat allocation of river dolphins (Inia geoffrensis and Sotalia fluviatilis) within the Pacaya/Samiria Reserve. Data were managed and analyzed using primarily Geographic Information Systems. Throughout Peru, dolphins of both species are found widely in the main rivers, in most free-flowing tributaries wider than 12m and in many larger lakes, at least during high water. Within the Samiria and its tributaries, they were most often at or near (within about 0.32nm of) confluences (63 percent), sandbars or other shoals (16 percent) or particularly sinuous segments of river (11 percent); in all these areas they occurred significantly more than expected in slow counter-current eddies. Within lakes, they were found usually within about 100m of shore (Inia geoffrensis) or equally frequently throughout the lake (Sotalia fluviatilis). Observed group densities were corrected [with data obtained independently (from shore sites, anchored vessels and drifting skiffs) on group size, dive durations, and persistence of water surface disturbances permitting detection] to estimate density and abundance of each species within the river. Densities of dolphins in the study area were higher than densities observed to date for marine dolphins; however, for river dolphins it may be more meaningful to refer to encounter rates and total numbers than to densities.

SUMMER DISTRIBUTION AND GROUPING PATTERN OF BELUGAS IN ST.LAWRENCE ESTUARY: AN INSIGHT INTO THEIR SOCIAL STRUCTURE

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The St.Lawerence beluga population ranges during summer within a small section (200 km) of the estuary. Systematic aerial (N=20) and boat surveys (249 transects covering 4996 km) between 1986 and 1992 were used to describe its summer distribution and grouping pattern. Aerial surveys using two aircrafts allowed completed coverage of the summer range within less than 4 hours and yielded almost instantaneous images of the distribution and grouping pattern of the entire population. Total visual counts averaged 449,9 whales (coeff. of variation = 9,2 %) distributed in 19 to 35 aggregations refered to as herds. Herd composition was described from the boat transect observations (325 herds; 6280 individuals) using the proportions of calves, juveniles and adults estimated from relative size and coloration. A clear and persistent spatial segregation between adult and adult and juvenile herds roughly coincided with the boundary between the middle and lower estuary. Herd size (2 to 209) and group size (1 to 16) varied considerably suggesting an ever-changing dynamic. Jarman's typical group (herd) size and frequency distribution of animals in arbitrarily defined size-classes were used to compare grouping pattern. More than 80 % of the whales observed in the lower estuary were found in herds of over 30 individuals, whereas such large herds accounted for less than 40 % of the whales in the middle estuary. Structural components of the habitat and different social requirements were hypothesized as important determinants of the dynamic structure and segregation pattern. This first analysis used simple and functional definitions of grouping independant of filiation or associations over extended periods of time. An ongoing long term study using photo-identification suggests site fidelity and the persistence of individual associations. Results from this program and application of new molecular techniques are needed to go beyond structural analyse into the study of social organisation.

SCOPEX: A MULTI-DISCIPLINARY OCEANOGRAPHIC STUDY OF A RIGHT WHALE FEEDING HABITAT IN THE GULF OF MAINE

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Western North Atlantic right whales (*Eubalaena glacialis*) aggregate in the spring in the Great South Channel (GSC) region in the southwestern Gulf of Maine, where they feed on extremely dense patches of the copepod *Calanus finmarchicus*. The South Channel Ocean Productivity EXperiment was conducted by a large team of investigators in 1988 and 1989 to define the physical and biological oceanographic factors responsible for the development of those prey patches. GSC hydrography is characterized by cyclonic flow at all depths in the center of the region, a southerly low-salinity surface current on the west side, and a northeasterly current on the east side (part of the anticyclonic Georges Bank gyre). A persistent thermal front separates stratified waters with warmer surface temperatures from totally mixed waters over the shallower areas. *Calanus* abundances are among the highest measured in the North Atlantic, with a maximum density of 331,000 m^{-3} in one 1989 sample. Zooplankton were extremely aggregated in the vertical dimension, with strong diel vertical migration in 1988 but not in 1989. Zooplankton densities also varied by up to three orders of magnitude in the horizontal, with patch dimensions of 250-500 m. Right whale locations were most closely correlated with maximum densities of the largest *Calanus* life-stages, with their diving patterns and horizontal movements closely coupled to the density, vertical migration, and horizontal patchiness of the zooplankton. The SCOPEX evidence supports the hypothesis that high GSC *Calanus* abundance is due to advection from upstream in the Gulf of Maine and concentration within a large-scale near-surface area of convergence, rather that *in situ* productivity or upwelling within the GSC.

HABITAT ÜBER ALLES!

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The future of whales depends upon the continued availability and suitability of their critical habitats. However, for many species these reasonably important areas remain largely unknown. Often little is also known about why the areas they inhabit are preferred. Recent detailed studies on a few species suggest some feasibly high site fidelity for benthic feeding gray whales versus wide-ranging searches in these dimensions by others. In "normal" years, most species show preferences for areas where their prey are usually found in high concentrations. The regular use of banks, basins, escarpment edges, ice edges and offshore canyons for feeding can often be attributed to increased productivity or prey concentration from areas of upwelling, eddies, convergence zones and river plumes.

For some of the same reasons, these areas are also used to harvest fish resources by man. Whale habitats for feeding, breeding and calving are commonly nearshore and, thus, exposed to nets, commercial shipping, mineral exploration/production and recreational boating/tourism. Without appropriate attention to these potentially competitive uses, the future of whales will be lost not because of commercial hunting, but the loss of critical habitat due to ignorance and benign neglect. We must strengthen our efforts worldwide to understand why certain areas are so important to whales and how man's activities can co-exist without adverse impact.

ENVIRONMENTAL FEATURES AND CETACEAN HABITATS IN THE ALASKAN ARCTIC

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Bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*) and beluga whales (*Delphinapterus leucas*) feed in and migrate through waters offshore northern Alaska. All three species are apex consumers in the short food webs common to polar regions. Bowheads feed primarily on zooplankton, gray whales siphon epi- and infaunal crustaceans from the benthos and belugas prey on a variety of nekton including crustaceans, cephalopods and fishes. Extensive observational data were gathered on these species during aerial surveys offshore northern Alaska from 1982-91. Patterns of distribution and relative abundance described from these data suggest that species-specific habitats can be defined based on environmental features, especially water depth and ice cover. Analytical methods for correlating cetacean habitats and environmental features in the Alaskan arctic will be discussed.

THE USE OF A GEOGRAPHICAL INFORMATION SYSTEM IN EXPLORING CETACEAN HABITAT USE.

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A generalized schema for storing and displaying cetacean sightings data by means of a Geographical Information System is described. The object of such work is to enable data from a variety of survey types to be displayed in a similar format, in order to provide a visual assessment of relative densities and seasonal distribution in relation to physical or biological features. Using the software package Arecinfo, cetacean sightings data form several different surveys have been tabulated and displayed using a common format. Effort and sightings data are stored in separate tables which allows a flexible approach to query and display of the distributional data. Calibration between survey types may also be incorporated. Cetacean sightings survey data are used here to produce distribution maps for both the Northeastern US and the northeast Atlantic. Observer data from the Gulf of Maine sink gillnet fishery are also used to show the distribution of harbor porpoise kills in a similar format. These distribution maps may then be compared with fishery survey data, commercial fish catch data, or oceanographic data displayed to a similar format and scale. The advantages and disadvantages of using a GIS for this kind of work are discussed.

HABITAT PREFERENCES BY CETACEANS IN THE CENTRAL MEDITERRANEAN SEA.

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Habitat preferences by seven cetacean species (fin whale, sperm whale, long-finned pilot whale, Risso's dolphin, bottlenose dolphin, striped dolphin, and common dolphin), observed in the Central Mediterranean Sea during dedicated cruises between 1986 and 1993, were studied by considering water depth, surface temperature, and distance from the nearest coast at the location of each sighting. Depth differences among all species were highly significant (ANOVA F-ratio=110.722, $P<<0.001$). Fin whales, pilot whales, and striped dolphins were markedly pelagic; fin whales were found in warmer waters than striped dolphins (t-value=2.781, D.F=115, $P<0.01$), perhaps indicating a preference by the former for the warm side of frontal systems, which might be related to their feeding activities. Sperm whales and Risso's dolphins were commonest on the continental slope. Bottlenose dolphins and a community of common dolphins found in the Ionian Sea were conspicuously neritic; however, common dolphins seen west of Sardinia and Corsica were pelagic, and occasionally occurred in mixed groups with striped dolphins. Differences among species are discussed in view of their known feeding habits and of the characteristics of the Mediterranean marine environment. The importance of the antropic influence on the choice of habitat by cetaceans was investigated, by comparing the distribution of single species in areas exposed to different degrees of human-induced disturbance and damage.

CETACEAN HABITATS IN THE CALIFORNIA CURRENT: A CANONICAL CORRESPONDENCE ANALYSIS

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Cetacean abundances and oceanographic conditions were sampled during a three month ship survey on the 53 m NOAA R/V McArthur within the California Current between the Mexican and Oregon borders, 28 July - 5 November, 1991. We used canonical correspondence analysis, an eigenvector ordination technique that includes direct gradient analysis, to investigate cetacean habitat use and community composition. Environmental variables included in the analysis were: surface temperature, salinity, chlorophyll, primary productivity, mixed layer depth, 14°C isotherm depth, variables representing the vertical and horizontal range of temperature, salinity and chlorophyll, plus latitude and longitude to represent fixed geographic effects. The first four axes of the ordination were significant with species-environment correlations of .93, .84, .74 and .78. The dominant pattern (1st axis) separated whitesided dolphins, N. right whale dolphins, harbor and Dall's porpoises, minke and Baird's beaked whales from bottlenose dolphins, blue, sperm, pygmy sperm whales, Ziphiid and Mesoplodont beaked whales. The former group occupied more northerly, cold, upwelling areas, and the later groups occupied more southerly, warm less-productive waters of the Current. The second axis also separated faunal groups based on high and low productivity, but contrasted onshore - offshore habitats. The offshore, more productive waters of the California Current were occupied by shortbeaked common dolphins, striped dolphins, sperm and beaked whales. The more onshore (but pelagic, not coastal) waters of the California Current were occupied by longbeaked common dolphins, bottlenose dolphins, minke whales. The first two axes cumulatively explained 24% of the variance in cetacean abundance. All four axes together explained 32%. For individual species this ranged from 65% for Dall's porpoise, over 50% for both species of common dolphin, to just 2% for Bryde's whales.

SPATIAL PATTERNS OF SIX CETACEANS ALONG A LINEAR HABITAT

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Shelf edge waters, principally 200 to 2,000 m, off the northeast U.S. coast encompasses a cetacean high use linear habitat extending between Cape Hatteras and Georges Bank. In spring/summer 1991 and 1993, fine scale vessel surveys were conducted using line transect methods to collect abundance and habitat use data for cetacean populations in this region. The 1991 survey encompassed the entire region, whereas 1993 effort was concentrated along southern edge of Georges Bank.

Six small cetaceans, *Mesoplodon* sp., *Globicephala* sp., *Tursiops truncatus*, *Grampus griseus*, *Stenella coeruleoalba*, and *Delphinus delphis* were sighted in both surveys. Analysis of 1991 and 1993 (under way) data indicates general distribution patterns are similar to those reported in previous studies. However, spatial gradation in species sightings along the shelf edge suggests fine scale habitat selection occurs. Bathymetric and oceanographic features appear to be important factors influencing habitat use.

SYMPOSIUM: Marine Mammals and Low-Frequency Sound

MARINE MAMMALS AND LOW FREQUENCY SOUND.
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As shown by the Heard Island feasibility study and the planned Acoustic Thermography of the Ocean Climate experiment, low frequency sound is an important tool in the exploration of the ocean. In an effort to understand whether these sounds impact marine mammals, the Office of Naval Research initiated a research program to enhance our understanding of the role of low frequency sound to marine mammal biology. The papers presented in this symposium were either sponsored by or carried out in coordination with ONR's program. Ultimately we hope that the results of studies like these will help us to better understand the potential affect of low frequency acoustical measurements on marine mammals. ONR has an on-going program into the effects of low frequency sound on marine mammals and is interested in receiving proposals that will provide insight into the role of low frequency sound in marine mammal communication, orientation, navigation, prey detection and predator avoidance.

WHALES '93: THE APPLICATION OF THE NAVY IUSS FOR LOW-FREQUENCY MARINE MAMMAL RESEARCH
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In the fall of 1992 the US Navy initiated the **Whales '93** program to evaluate its Integrated Undersea Surveillance System (IUSS) for detecting, locating, and tracking whales, and determining their seasonal distributions and movements. The initial results are nothing short of extraordinary and indicate that low-frequency, passive acoustics can be used to describe large-scale seasonal distributions, movements, and relative abundances for pelagic whales. In the first nine months many tens of thousands of detections of blue, finback, humpback, and minke whales have been made; many hundreds of animals have been located, and many tens of individuals have been tracked for periods ranging from hours to many weeks. Each species produces distinctive types of sounds. While there is a surprising amount of variability in the sound repertoires for blue and finback whales, individuals show remarkable stereotypy in the FM structures and timings of their long, patterned sequences of infrasonic calls. Minkes produce rapid sequences of pulses that are repeated at regular intervals, and it appears that individuals produce sounds that are consistent in pulse frequency, pulse repetition rate, and inter-sound interval over periods of at least 3-4 hours. Results on species specific sound repertoires, within- and between-ocean comparisons, individual calling behaviors, and large-scale seasonal distributions and movements will be presented. The potential functions of the whales' different low-frequency signaling behaviors will be discussed including communication, navigation, and food finding.

MONITORING MARINE MAMMALS USING THE U.S. NAVY'S INTEGRATED UNDERSEA SURVEILLANCE SYSTEM (IUSS)
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During the Cold War, the pursuit of submarines by the U.S. Navy was of the highest priority. A sophisticated, highly sensitive underwater acoustic network of global proportions was developed and installed: the Integrated Undersea Surveillance System (IUSS). This network includes thousands of miles of cable, high tech hydrophone arrays, a small fleet of towed-array vessels, and a shore processing system. In attempting to locate ever quieter targets, processing techniques were refined; sound inputs from other sources, of which whales is one, were routinely discarded. Until recently, marine mammals had never been investigated using this global underwater surveillance system. A limited test was conducted in the Western North Atlantic basin to evaluate the capabilities of fixed passive acoustic arrays (SOSUS) to detect, localize, and track three whale species: fin, humpback, and right. Preliminary results clearly indicate that significantly more data are being generated than previously expected, some of it surprising as well as controversial. This first glimpse of an ocean basin-wide, synoptic picture of marine mammals will be presented.

LOW FREQUENCY TUNING IN MARINE MAMMAL EARS
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Hearing is a relatively simple chain of events: pressure waves (sounds) are converted by mechanical transducers (middle and inner ear) into electrical signals (neural impulses) that provide a central processor (brain) with a window on the world. The view through that window differs drastically for each species. Audible frequency range varies with species and, in part, reflects selection pressures important to that species. That is, all animals share three drives for which sounds provide crucial cues: feed, reproduce, and avoid death. Thus, a species' auditory view is colored by its hearing capacity which in turn is dictated by a sensory apparatus shaped through evolution. Therefore, understanding an animal's hearing can provide important insights into its behavior and clues to general questions of how ears hear diverse frequencies.

Through time, the mammalian ear evolved into an elegant structure. Depending upon your predilections, "elegant" may conjure up a two line mathematics proof or a tall blond, but in ears, elegance is the packing of over 75,000 mechanical and electrochemical components into less than 1 cm^3. Comparative studies of terrestrial mammal ears show structural variations in these components predict differences in hearing capacity. Preliminary results in a study using similar techniques on cetacean ears found significant variations in middle ear volume, ganglion cell distributions, osseous laminar construction, and basilar membrane dimensions. Functional analyses of these data indicate that while many species have ears with a relatively poor capacity below 50 Hz several larger mysticete species have cochlea tuned to peak sensitivities below 20 Hz. The studies also show that the anatomy of sound paths to the ear differ among Cetacea and that lateral soft tissue channels exist that may be specialized for the transmission of lower frequencies.

EXPERIMENTAL PLAYBACK OF LOW FREQUENCY NOISE TO BOTTLENOSE DOLPHINS, *TURSIOPS TRUNCATUS*.
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A resident population of bottlenose dolphins near Sarasota FL was selected for playback experiments of low frequency noise. Dolphins were tracked visually from a coastal observation site using a theodolite. Most playback subjects were identified, with sex and age known from prior observations. Some individuals had playbacks repeated on six days. The three playback stimuli involved a 800-900 Hz M-code stimulus: 1)12 sec duration with a source level of 150 dB re 1 μPa (12 tracks); 2) 150 sec duration at 170 dB (16 tracks); 3) continuous at 170 dB (4 tracks). There were 39 control tracks. Comparison of swimming speeds, dive duration, and behavioral displays showed no significant differences, although there appeared to be a weak trend for dolphins to display less during and after playback. Comparison of the closest points of approach of paired control and experimental tracks showed no significant differences. Most of the dolphins in the 170 dB playbacks were exposed to sound levels in excess of 120 dB, even though they could easily have avoided this exposure. This apparent lack of response differs from similar studies of migrating gray whales and of playback of the same M-code to sperm whales. While this may reflect species-specific differences, recreational boat traffic was so common and so loud in Sarasota study site that these animals may have habituated to noise exposure.

SYMPOSIUM: Interactions of Immunology and Toxicology

THE *IN VITRO* DETERMINATION OF CETACEAN-SPECIFIC OH AND PAH TOXICITY

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Elevated levels of organohalogen (OH) and polycyclic aromatic hydrocarbon (PAH) residues found in the tissues of a variety of cetacean species have been proposed to occur concomitantly with recent dolphin strandings and deaths proposed to be epizootic in etiology; however, the physiological consequences of chronic cellular exposure to low environmental levels and higher bioaccumulated levels of potentially toxic OH and PAH are unknown. We have utilized viable tissues from freshly dead animals and epithelial cell lines derived in this laboratory to investigate the biochemical and molecular responses of cetacean cells to OH and PAH exposure.

Dolphin skin and lung samples incubated in the presence of OH or PAH showed induction of enzyme activities associated with cytochrome P450 metabolism of xenobiotics. A dolphin epithelial cell line, CDK, was found to express *CYP1A1* and the *Ah* receptor, and to show characteristic mammalian responses to OH and PAH exposure, including the induction of CYP1A1 activity, benzo(a)pyrene (BaP) metabolism, dose-dependent BaP inhibition of mitosis, formation of BaP-DNA adducts, and BaP-initiation of DNA excision repair. TCDD decreased mitosis in CDK, depleted glutathione at concentrations as low as 10^{-12} M, and, when used at 10^{-10} M to pre-treat cells prior to BaP exposure, initiated increased DNA damage by BaP. These data suggest that OH and PAH synergisms result in significantly increased genotoxicity to dolphin cells. *In vitro* analyses such as these will contribute to a greater understanding of cetacean interactions with xenobiotic contaminants in the nearshore environment.

CONTAMINANTS AND DISEASE RESISTANCE: EPIDEMIOLOGICAL CONSEQUENCES

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Recent large scale mortalities of marine mammals have been caused by viral pathogens. A wide range of such pathogens are prevalent in marine mammal populations and this has stimulated interest in the ecological role of these agents. Much of this interest has focused on the contributory role of immunotoxins in disease outbreaks. I will review the results of recent studies of the effect of contaminants on the immune system of seals. I will focus on my own studies of immune function development in grey seals. During lactation, the pups of phocid seals are exposed to easily measured and sometimes substantial quantities of contaminants in their mothers' milk, providing an opportunity to assess the immunotoxic effects in free-living individuals.

Such studies demonstrate the effect of contaminants on immunocompetence in individual seals but the epidemiological implications of these effects depend on the population consequences of individual responses. The net rate of disease transmission is central to all mathematical models of the epidemiology of infectious diseases. This rate has a spatial component, determined by the behaviour of individuals, and a physiological component, determined by the individuals' immunological responses. Both components must be quantified in any realistic model and it is therefore important that immunologists, toxicologists and ecologists continue to work closely together.

DEVELOPMENT AND APPLICATION OF IMMUNOLOGICAL TECHNIQUES AND SPECIES-SPECIFIC REAGENTS FOR VARIOUS MARINE MAMMAL SPECIES

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As our ability to document unexplained mortalities and strandings of coastal species has increased, so has our awareness of the plight of marine mammals and our interest in their health. Direct correlations between exposure to pollutants and their effect(s) on the immune systems of marine mammals have not been made. The consequences of exposure could be either immunosuppressive or immunoenhancing. Cases in which pathogenic agents have been isolated from mortalities or from stranded animals may represent incidental infections; alternatively, increased sensitivity to pathogens could be opportunistic, resulting from immunosuppression related to contaminant exposure. In addition, no one has addressed the latter possibility of immunoenhancement; autoimmune or hypersensitivity reactions can, indeed, result from toxin exposure as has been shown in terrestrial animals. Before we can demonstrate any association between pollutant exposure and immune abnormalities in marine mammals we absolutely must acquire a basic understanding of the immune systems of the various coastal species.

We have been engaged in establishing an extensive panel of reagents and techniques for the comprehensive assessment of immunologic health and for the determination of standard immune system profiles of several marine mammal species, including the bottlenose dolphin, killer whale, California sea lion, and the harbor seal. Such tools and data will be used to define potential associations between acute and/or chronic exposure to chemical pollutants, any overt symptoms and clinical evaluations of these animals, and specific immune system dysfunction.

MULTIPLE RESPONSE APPROACH TO ASSESS IMMUNOLOGICAL AND TOXICOLOGICAL SIGNIFICANCE OF CHLOROBIPHENYLS IN MARINE MAMMALS.

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Effects of contaminants on marine mammals have predominantly been observed as reproductive and immunological disorders. The potentially exerted toxicity of organochlorine residues (OCs) found in marine mammals is in this approach evaluated by two principal sets of indicators: interactions of OCs with enzyme systems involving induction and biotransformation and a suite of comparative physical and chemical blood parameters.

Induction of the cytochrome P450 enzyme system is both compound and species specific, with the result that a characteristic enzyme profile for each compound in a given species may exist. Since the response is that specific, directed analyses to determine enzyme profiles in many different marine mammal species are needed. It is recommended to focus initially on four model substrates: EROD for CYP1A1, 4-OH,AA for CYP1A2, PROD for CYP2B and FAH for CYP4A. The biotransformation capacity will be expressed in the concentration of a certain biphenyl to the concentration of a recalcitrant reference biphenyl. This will be applicated for harbour seals and harbour porpoises, and the respective detrimental/mitigating consequences discussed.

Directly obtained blood parameters include levels of vitamine A, steroid hormones, thyroxine. Indirectly acquired parameters include mitogen- and antigen induced proliferative responses of peripheral blood mononuclear cells and natural killer activity, which provide comparative information on the immunocompetence of environmentally exposed individual animals.

It is concluded that such an integrated multiple response approach will advance the assessment of the immunological and toxicological significance of the residue levels of OC's found in marine mammals.

AN ANATOMICAL LINK BETWEEN THE NERVOUS AND IMMUNE SYSTEMS IN THE BELUGA, *DELPHINAPTERUS LEUCAS*

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Lymphoid organs were collected from belugas, *Delphinapterus leucas*, ranging in age from less than one to 16 years to investigate overall morphology and innervation at the light and electron microscopic levels. Morphology of beluga lymphoid organs was similar to that of other mammalian lymphoid organs with a few differences. Morphological distinctions between individual whales could possibly be attributed to age differences. Catecholamine fluorescence histochemistry and tyrosine hydroxylase (TH) (the rate-limiting enzyme in norepinephrine synthesis) and neuropeptide-Y (NPY) (a peptide often found colocalized with norepinephrine) immunocytochemistry was carried out to study innervation of the lymphoid organs. In addition to vascular and trabecular compartments, fluorescent and TH+ nerve fibers were present in parenchymal lymphoid compartments, where they were closely associated with cells of the immune system. NPY-containing nerve fibers were distributed in a similar pattern to TH+ fibers, suggesting colocalzation. In lymphoid zones, TH+ and NPY+ nerve fibers were observed in the periarteriolar sheath and marginal zone of the spleen; in the outermost portion of the cortex, the corticomedullary zone, and medulla of the lymph nodes; in the parafollicular zones and diffuse lymphocyte layer below the epithelium of the tonsil; in the outermost portion of some thymic lobules; and in the lamina propria of the gut. This anatomical link between the nervous and immune systems in the beluga may provide a means for external stimuli to influence immunocompetence. For example, physical or psychological stressors may result in altered immune responses, making the animal more susceptible to environmental pollutants and toxins, infection, and disease. Functional aspects of this anatomical link are under investigation.

MECHANISMS OF HAH TOXICITY

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Halogenated aromatic hydrocarbons (HAHs) including the polychlorinated biphenyls (PCBs), dibenzofurans (PCDFs) and dibenzo-*p*-dioxins (PCDDs) elicit a number of common toxic and biochemical responses including immunosuppressive effects, hepatotoxicity, carcinogenesis, reproductive/development toxicity, dermal toxicity and neurotoxicity. Many of the individual HAH congeners act through a common aryl hydrocarbon (Ah) receptor-mediated pathway and these compounds resemble 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) in their mode of action. Risk management of HAH mixtures has utilized a toxic equivalency factor (TEF) approach which assumes that the toxicities of individual congeners are additive. This study will report both additive and non-additive interactions with respect to immunotoxicity between different structural classes of HAHs. These results and other data indicate that the TEF approach should be used with caution due to (a) antagonistic interactions between some HAHs and (b) underestimation of the carcinogenicity of PCBs which act through Ah receptor-independent pathways.

SPECIFIC ACCUMULATION AND TOXIC IMPACT OF PCBs IN MARINE MAMMALS

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This paper presents overviews of the global contamination by PCBs and ecotoxicological implications of that contamination for marine mammals. The recent pattern of contamination by PCB residues in coastal environments was noticed to be prominent not only in developed nations but also in developing countries. Reflecting this, a worldwide contamination by PCBs was observed in the open ocean, including polar regions. The estimation of air-water interface mass transfer of PCBs suggested that the oceanic water bodies play a role as a sink for persistent contaminants.

In this regard, the marine mammals, particularly cetaceans, are one of the animal groups receiving high concentrations of PCBs arising out of a worldwide contamination. They can amplify much greater amounts of PCBs through feeding and also pass them in large quantities from one generation to the next through lactation. Unfortunately, these animals have a smaller capacity for degradation of these contaminants due to the specific mode of their cytochrome P-450 enzyme systems. These drug metabolizing enzyme systems may be related to the possible effects of persistent organochlorines, particularly coplanar PCBs. Furthermore, the residue levels of these contaminants in marine mammals are unlikely to decline in the near future. Considering all these facts, it may be concluded that marine mammals are one of the most vulnerable and possible target organisms in forthcoming long term toxicity of hazardous man-made chemicals.

SYMPOSIUM: International Marine Mammal Law Policy: New Duds on an Old Torso

A REVIEW OF THE DEVELOPMENT AND CURRENT STATUS OF MARINE MAMMAL MANAGEMENT IN CANADA.
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This paper analyzes the historical development of Canada's marine mammal management efforts. From early commercial whaling and sealing to their cessation, Canada used a mix of economic, biological and political criteria for regulation of the uses of marine mammals. The regulatory structure that has developed is, at least in part, due to the grey zone that ocean resources fall into within Canada's resource management institutional structure, and in part due to the political and economic profile of the animals. We present these options as reasons for ineffective management of species and marine mammal habitats

Throughout this time Canada also committed to international conservation efforts through the International Whaling Commission and more recently with CITES. The performance of international duties is also examined in comparison to other nations.

A critical evaluation of the current status indicates that, in the general sense, marine mammals are severely undermanaged. Research, regulatory structures, and policies are incomplete and do not reflect the overall value of Canada's marine mammal fauna. Yet, in particular situations some new initiatives show promise for the future management of marine wildlife and habitat. In combination the examination illuminates a country with low priority for marine mammal issues, yet with arising economic potential from items such as recreational whale-watching, and continued controversy in areas such as aboriginal hunting.

THE FIRST REGIONAL AGREEMENT ON CONSERVATION OF SMALL CETACEANS IN EUROPEAN WATERS
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Concerns over declining populations of dolphins and porpoise in the North Sea and their disappearance from the northern Baltic have led to the birth of a new Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). The final text was available for signing in March 1992 at the United Nations headquarters, New York, and was concluded under the auspices of the 1979 Bonn Convention of the Conservation of Migratory Species of Wild Animals. The interim secretariat for this Agreement has been set up at the Sea Mammal Research Unit in Cambridge commencing in June 1992. This Agreement covers all toothed cetaceans in the area encompassed by the Agreement excepting the sperm whale *Physeter macrocephalus*. The Agreement aims to manage and conserve their habitat, provide surveys and research, fully utilise by-catches and strandings for research, establish legislation prohibiting intentional kill, encourage research and technology for reducing incidental catches of cetaceans, and provide information and education to the public, including the fishing industry. Priorities already identified include potential impacts of fishing operations, pollution and noise on cetaceans, and the need for population surveys. The following Range States have now signed: Belgium, Germany, Netherlands, Sweden and the United Kingdom (either without reservation or will full ratification), and Denmark (now proceeding with ratification) The European Economic Community (EEC) has also signed. The Agreement is expected to come into force before the end of 1993.

IS IT TIME TO ABANDON THE "P" IN THE MARINE MAMMAL PROTECTION ACT
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During the summer of 1993 the Center for Marine Conservation and other conservation organizations negotiated an agreement with the commercial fishing industry to reduce the incidental mortality of marine mammals in commercial fisheries. Throughout the negotiations commercial fishing representatives asserted that certain marine mammal stocks, particularly on the West Coast, had grown so large that they need to be "managed" While negotiators from the conservation community were unwilling to discuss the development of "culling" programs, a regime to address "nuisance" animals was developed. That program would require strenuous procedural review and scientific documentation before an individual animal could be removed by public officials.

Nevertheless, questions remain as to how managers should deal with "robust" marine mammal stocks. The authors will discuss and review the literature surrounding questions such as: How do we scientifically define a "robust stock"--is it a stock at its Optimum Sustainable Population or one that is at or exceeding its carrying capacity? How should we define carrying capacity--current, historic, or social ("They're all around when I'm fishing so they're at carrying capacity")? What is a sound management program for marine mammals? How should we incorporate marine mammal protection and management into ecosystem management, and what is ecosystem management?

IS THE MARINE MAMMAL PROTECTION ACT BECOMING THE "SCIENTISTS FULL EMPLOYMENT ACT?"--THE ROLE OF SCIENTISTS IN REDUCING MARINE MAMMAL INCIDENTAL MORTALITY IN COMMERCIAL FISHERIES UNDER THE MMPA
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In 1988, Congress amended the MMPA to create an exemption allowing the incidental taking of marine mammals by commercial fishermen until October 1993. The data gathered as part of the "Marine Mammal Exemption Program (MMEP)" has identified approximately a dozen commercial fisheries that frequently interact with marine mammals. For roughly 20 stocks, that interaction may be considered significant to the recovery of that population. The data analysis will be available in the publication: A Review of the Incidental Mortality of Marine Mammals in United States Commercial Fisheries.

With the expiration of the MMEP the conservation community and the commercial fishing industry negotiated a new regime to reduce marine mammal incidental mortality. Congress is currently using this proposal as a basis for amending the MMPA. The authors will discuss the proposal's components such as marine mammal stock assessments, calculation of the "allowable removal level," conservation teams, a Scientific Evaluation Working Group, and an overall movement toward ecosystem management that will likely change marine mammal research priorities, funding opportunities, and the role of scientists in marine mammal conservation.

SYMPOSIUM:
Marine Mammal Mating Systems

RIVER COWS, SEA COWS, AND SEA PIGS: HABITAT AND MATING SYSTEMS IN THE SIRENIA
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Potential determinants of mating systems in recent sirenians include the inability to haul out for mating or calving, an exclusively or predominantly vegetarian diet, and little apparent opportunity for males to sequester either resources or harems. Births are single and widely spaced and calves maintain a close maternal association for over a year. The five recent species, however, belong to two long-distinct families with diverse habitats.

Manatees are riverine or estuarine and are generalist herbivores, feeding throughout the water column. Manatee females may advertise for mates by means of scent marks and, after active searches, manatee males form long-lasting aggregations about estrous females.

Dugongids are strictly marine. Steller's sea cow browsed on algae growing on rocky shorelines in cold-temperate to subarctic waters. Steller reported that the sea cow had strong pair bonds and was monogamous. The dugong is tropical and specialized for rooting into soft bottoms for seagrass rhizomes and invertebrates. Manatee-like behavior has been reported for the dugong, but dugongs also lek. Lekking male dugongs may rely on acoustic signals to defend territories and attract females.

I explore possible origins of sirenian mating system diversity in the light of habitat differences and theories as to the evolution of mating systems.

MATING SYSTEMS OF MARINE MAMMALS: A FRAMEWORK AND OVERVIEW
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The commonalty of animals considered to be "marine mammals" is that they have evolved to forage at sea. Despite this similarity, there is considerable diversity in their feeding habits, e.g., some species feed on aquatic vegetation, others feed on zooplankton or fish, and some prey on each other. Furthermore, the extent to which marine mammals live a marine existence varies. Some marine mammals are aquatic in all aspects of their lives (cetaceans and sirenians), but others have obligate or facultative use of land or ice for aspects of reproduction and thermoregulation (pinnipeds and marine otters). These differences should produce diversity in the mating systems of marine mammals.

A useful approach to understanding mating systems of animals has been to examine the interplay between sexual selection, and ecological and phylogenetic factors. Two basic themes of models are: 1) males should maximize number of mates, whereas females should maximize parental care and mate choice, and 2) female dispersion is influenced mainly by distribution of resources, whereas male dispersion is primarily determined by female dispersion. Since marine mammals lactate, precluding male parental care, we should expect marine mammals generally to exhibit polygynous mating systems. The influence of female dispersion on male mating strategies is apparent from a variety of studies. For example, in terrestrially mating pinnipeds where females aggregate and are sedentary during the reproductive period, male defense of harems or territories leads to the monopoly of numerous females by a single male; whereas, in the same or similar species with thermoregulatory movements of females, lower levels of polygyny and different mating strategies have been identified. In the sperm whale, differences in dispersion of female groups affects whether males remain with a group or move between groups to obtain mates. Recent evidence from aquatically mating marine mammals, including cetaceans, sirenians, sea otters, and pinnipeds, suggests that low levels of polygyny are likely and that female choice and sperm competition may be of greater importance and direct male competition of less importance to their mating systems.

THE ECOLOGY OF DELPHINID SOCIAL BONDS AND MATING STRATEGIES

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Apes and dolphins exhibit remarkable convergence in social organization yet key features of dolphin society may be unique among mammals. Such comparisons will help us to generate hypotheses about ecological influences on dolphin social organization and mating strategies. For example, strong male-male bonds and weaker female-female bonds characterize bottlenose dolphin and chimpanzee fission-fusion societies. In bonobos and possibly killer and pilot whales, males bond strongly with their mothers. The chimpanzee-bonobo transition from male-male to mother-son bonds is thought to be associated with the continuous availability of large food patches in bonobos which reduces feeding competition and allows male bonobos to travel with their mothers. A similar explanation may apply to differences in the social organization of bottlenose dolphins and killer and pilot whales. However, female chimpanzees and bonobos typically emigrate from their natal groups, while both sexes may be philopatric in bottlenose dolphins, and killer and pilot whales. I suggest that the critical feature favoring natal philopatry of both sexes in dolphins is their relatively low cost of locomotion. Low costs of locomotion allow 1) bottlenose dolphins to live in large social networks where males may maintain social contacts in their natal areas but range widely to gain access to unrelated females, 2a) allow killer an pilot whales groups to range widely where they may encounter other pods with receptive females, or 2b) allow male killer and pilot whales to leave their mothers to travel temporarily with other pods.

THE JUAN FERNÁNDEZ FUR SEAL: WHAT IT TELLS US ABOUT THE DETERMINANTS OF OTARIID MATING SYSTEMS
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The prevalence of aquatic territoriality and aquatic mating in the Juan Fernández fur seal illustrates a central relationship underlying the evolution of otariid mating systems. That is, male mating strategy depends primarily upon female distribution. Measurements of male reproductive behavior and territoriality in the Juan Fernández fur seal from 1987-1992 show that males compete for sites preferred by females, which, in turn, are determined by climate and topography. These sites include favored birthing and resting sites on land as well as protected aquatic areas where females traditionally congregate during hot afternoons. Males defending aquatic territories achieved as many copulations as those holding landlocked or shoreline territories. Males returned to the same territory for as many as 6 years in succession and without exception maintained their strategy as either terrestrial or aquatic. Young males showed a predisposition toward either terrestrial or aquatic territoriality, defending post-season territories which they later in life defended as breeding season males. The range and variation in male mating strategies among otariids, as illustrated by defense of "milling" sites in California sea lions, and varying degrees of territoriality in southern sea lions, can be expected to be as varied as is the way that females use the resources where they and their male consorts congregate.

LOOKING FOR LEKKING: NEW PERSPECTIVES ON PINNIPED MATING SYSTEMS

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Many pinnipeds that breed in the water appear to be lek breeders, including walruses, Weddell seals, and the common or harbor seal. More surprising examples of lek breeding have come from California sea lions (Heath, 1987), Steller sea lions (Gisiner, 1992) and South American fur seals (Majluf, pers. comm.). In these, and many other pinniped species, breeding takes place on or near the pupping sites and male reproductive success has been assumed to depend on direct control of females or on control of female access to resources. However, in the studies cited above male reproductive success did not depend so much on the number of females or pupping sites a male controlled, but was best correlated with intrinsic male features leading to direct or indirect female choice.

General models of lek breeding applied to these pinniped mating systems offer exciting new perspectives on a) the role of marginal males, b) male lifetime reproductive strategies, c) the relative roles of immediate versus heritable benefits in female mate choice, and d) the costs and benefits of colonial breeding.

DIVERSITY IN SOCIAL ORGANIZATION AND MATING SYSTEMS OF MARINE OTTERS: WHAT ARE THE DETERMINANTS ?

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Of the 13 extant otter species, all except one, the sea otter, (Enhyrda lutris), have obligate ties to land. However, 9 of these species have coastal populations exhibiting facultative use of the marine habitat. Highly variable social organization and mating systems characterize the Lutrinae in general, a most ecologically diverse and behaviorally flexible group. Yet, among just those otter populations inhabiting marine environments, variability in social structure and mating behavior is extreme. In the solitarily foraging sea otter, sexual segregation and male gregariousness prevails, with strong territorial polygyny, particularly in some populations. Along the Monterey coast, California, the same males hold long-term, year-round territories, a behavior possibly unique to this population. Territories may not be related to food resources. Females may reside in one territory, forage throughout several, yet mate in any one of the territories.

In other marine populations, social organization ranges from apparently monogamous groups in the marine otter, Lutra felina, to a variation of intrasexual territoriality in the European otter, Lutra lutra, to a clan type of territoriality reported in the North American otter, Lutra canadensis, and in the African Cape clawless otter, Aonyx capensis.

Ecological conditions may facilitate the evolution of different types of societies, but other selection pressures resulting in varied effects on different individuals must contribute to type of social organization and mating system as a result of individual strategies to maximize reproductive success.

MATING SYSTEMS OF BALEEN WHALES

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Most populations of baleen whales are characterized by a strong annual cycle with summer feeding and winter breeding seasons. Limited observations of sexual activity, primarily in coastal waters, suggest that mating often takes place in multi-male groups. Male-male competition has been observed in humpback whales, less so in balaenid and gray whales, which may exhibit sperm competition. Humpback whales are the best known species; male humpbacks clearly fight for access to a female and produce a song that appears to be a reproductive advertisement display. However, even for humpbacks, little is known about how free a receptive female may be to choose a mate, and what criteria she may use for choice. Use of acoustic location of singing males and tags to follow males and females may help specify ranging patterns on the breeding grounds and interactions within and between the sexes. Genetic analyses of paternity will soon supplant the meager observations of mating for humpbacks, right whales and other well sampled populations. Bowhead whales and several pelagic balaenopterid species also produce loud vocalizations that may function in reproductive advertisement. Long range acoustic location of whale vocalizations may help identify the location and behavior of these species during the breeding season. Many terrestrial species are easier and cheaper to study, but the major research efforts described above can be justified for endangered species where human activities may disrupt mating.

SUB-ICE BEHAVIOR OF RINGED SEALS AND THE POTENTIAL FOR POLYGYNY AMONG ICE-INHABITING SEALS.

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Species richness among pinnipeds increases from low to high latitudes, contrary to the common ecological pattern. Contributing to the reversal of that pattern is the great expanse of seasonal sea ice, which provides extensive breeding habitat for pinnipeds in high latitudes. The more limited area available on their insular breeding habitats has been invoked in the explanation of polygyny among species breeding at lower latitudes. Whether the vast area of sea ice leads to monogamy or lower levels of polygyny has been difficult to assess, because behavioral data on ice inhabiting species have been difficult to collect. Ringed seals are of particular interest as primitive, ice adapted seals. We used a sonic tracking system to record ringed seal movements and behavior under the sea ice during the breeding season. Most ringed seals used more than one breathing hole and lair, and holes commonly were shared. Both sexes foraged throughout the breeding season, but adult males spent less time at depth than did females and non-breeding males. Monogamy seems unlikely, although the potential for extensive polygyny appears to be limited by snow and ice conditions that limit the density of birth lairs and, hence, the potential for males to monopolize estrus females.

THE BREEDING BEHAVIOR AND MATING SYSTEM OF WALRUSES

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Observations on the breeding behavior of walruses provides a unique opportunity to assess how sea-ice conditions, female aggregation and aquatic mating influence the degree of polygyny and form of pinniped mating systems. Most ice-breeding pinnipeds mate in the water, pup on the sea ice, and are less gregarious during the breeding season than species using terrestrial parturition sites. They usually exhibit a low level of polygyny and have either a promiscuous or serially monogamous mating system. Given that walruses also mate in the water and pup on ice, one would predict them to be similar. However, because female walruses are highly gregarious during the breeding season, there is potential for a higher degree of polygyny and other forms of mating systems to evolve. Our observations on Atlantic walruses breeding in a polynya habitat in the Canadian High Arctic indicate that they are indeed, moderately polygynous and have a female defence mating system. Pacific walruses breeding in a pack-ice habitat in the Bering Sea are also thought to be moderately polygynous and may have a lek-like mating system. Female gregariousness appears to have facilitated the evolution of these mating systems under ecological conditions that have precluded such systems from developing in most other ice-breeding pinnipeds. Differences in the breeding behaviour and mating system of Pacific and Atlantic walruses may be related to the ice conditions and density of walruses in the breeding area.

BREEDING BEHAVIOUR OF SPERM WHALES

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Female sperm (Physeter macrocephalus) whales and their offspring are gregarious at several spatial and temporal scales. They form long-lasting, and probably familial, units, which feed together in structured groups and temporary aggregations. The feeding aggregations are clustered into concentrations of sperm whales tens of kilometres across, which themselves may be separated by hundreds or thousands of kilometres. Large mature males, which do not seem to form coalitions, spend periods of weeks or months within a concentration, roving between the groups of females, generally spending only a few hours with each. Roving between groups would be more profitable for males in terms of the number of oestrous females encountered when the oestrous period of a female is greater than the mean interval between encountering groups of females. Similarly, males would be expected to remain within concentrations of females when the travel time between concentrations is greater than the female oestrous period. Both conditions are probably met for sperm whales.

SYMPOSIUM:
The Range of Dolphin Cognition

THE ROLE OF COGNITION IN ALLIANCE FORMATION IN BOTTLENOSE DOLPHINS (TURSIOPS SP.)
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Social relationships in many primate species are surpisingly complex, leading to suggestions that the interplay between conflict and cooperation in individual social relationships may have selected for greater cognitive abilities. In Shark Bay, Western Australia, we have documented complex social relationships in a large brained delphinid, the bottlenose dolphin (Tursiops sp.). Male bottlenose dolphins participate in two levels of alliance formation. Males in stable pairs and triplets, "first-order" alliances, cooperate to herd individual females. Two first-order alliances may cooperate as "second-order" alliances to attack other alliances or defend against such attacks. Cooperation appears to be promoted by affiliative contact behaviors such as petting and rubbing, and possibly synchronous swimming and displays. Conflict is evident within both first and second-order alliances. Whether two alliances have an affiliative or agonistic interaction may be influenced by the presence of other alliances. To succeed in a complex social network, individuals must be able to evaluate relationships between other individuals, including those not present in a given situation. This is particularly true in the bottlenose dolphin's fission-fusion society. Nested alliances may place an additional burden on cognitive abilities if individuals are required to evaluate the possible consequences of particular strategies at each level of alliance. Nested male alliances with both agonistic and affiliative interactions between particular alliances have been reported only in humans and bottlenose dolphins. Selection for greater cognitive facility in the social domain may have produced very large brains in primates and dolphins.

COGNITIVE STUDIES OF SYMBOLIC COMMUNICATION, TOOL USE, AND ECHOLOCATION AT THE LIVING SEAS, EPCOT CENTER.
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Preliminary results from 3 ongoing cognition research projects with bottlenosed dolphins (*Tursiops truncatus*) will be discussed. The Keyboard Communication Project is a long term study attempting to teach dolphins to use an underwater keyboard to communicate with humans via symbols about objects, locations, and actions within a common environment. Preliminary evidence suggests that in the absence of explicit symbolic matching training the dolphins are learning to comprehend symbols used by humans. They also spontaneously produce symbols consistent with their subsequent behavior. In the Tool Use Project, dolphins have learned by observing humans to use several tools to obtain otherwise inaccessible food. More importantly, the dolphins have also used a tool in a novel situation without the aid of human demonstration. In the Passive Listening Project, a dolphin was allowed to listen as a second dolphin inspected a stimulus object via echolocation. The listening dolphin was able to use information produced by the other dolphin to select the matching object in a 3-choice delayed matching to sample task. These projects illustrate the unique contributions of laboratory studies to the understanding of dolphin cognition, as well as some general implications for dolphin ecology.

THE RHYTHMIC ORGANIZATION OF DOLPHIN SOCIETY
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The oceanic spinner dolphin lives its entire life in a school swimming in three-dimensional open space. The result seems to be that the organizing dynamics of its society can be observed with unusual ease. They appear to be expressed as analog states determined and changed by group process.

The various behavioral states that make up the dolphin's 24 hour day form a quite regular repeated sequence that appears to be mediated by rhythmic patterning. Other temporal patterns, such as annual sexual cycles form a contrapuntal analogic overlay upon the diurnal pattern. Individuals and the two sexes play these patterns off against one another as part of the mechanism that determines the behavioral synchrony of the entire school. Thus the "routine decision making" of the school appears to be less of an individual matter than a group process in which the entire school is involved. The importance of this view to the questions of communication, language, and cooperation is discussed.

SELF-SELECTION AND SELF-MONITORING OF ACTIONS BY BOTTLENOSED DOLPHINS
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Two bottlenosed dolphins (Tursiops truncatus) were taught to respond to a single gesture (glossed as "ANY") by performing an action of their choice from among a set of five (OVER, UNDER, TAIL-TOUCH, PEC-TOUCH, MOUTH). For reward, a given behavior could not be repeated more than twice in succession. Both dolphins learned to restrict their responses to only those five actions, and to offer the behaviors in roughly equal proportions across testing sessions. During a set of five test sessions, Akeakamai made repetition errors on only 8 out of 190 trials (4.2%), while Phoenix made 14 repetition errors out of 172 trials (8.1%). These results reveal a capability for self-directing and self-monitoring of behaviors.

In a related study, five non-iconic symbols were associated with each of the five actions. First, a specific behavior was elicited by a unique gesture previously learned by Akeakamai, and she was required to perform that behavior and then choose the corresponding symbol. Over the last five sessions of 99 trials, Akeakamai self-selected one of the five actions in response to the ANY gesture, performed the action, and then selected the corresponding symbol 85 times (85.85% correct, $p<.05$).

The ability of the dolphins to both self-direct and monitor their own behaviors may contribute to this species' social behaviors in the wild, such as alliance formations. Such complex alliances seemingly require the dolphins to keep careful track of their own actions and the actions of others.

THE SYNERGY OF LABORATORY AND FIELD STUDIES OF DOLPHIN COGNITION
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In many areas of animal behavior, a synergistic relationship develops between laboratory and field studies, each contributing information and ideas to the other. Likewise, in this symposium we have tried to show that the data from each area of research contributes to the increased understanding of the range and depth of cognition in dolphins and the modes of its expression in the natural world of these animals. Papers at this symposium from the laboratory have illustrated such cognitive skills as tool use, abstract concept formation, self-monitoring and regulation of behavior, sensory integration, and shared communication. Field studies have revealed shared communication, referential communication, social monitoring and manipulation, and vocal adaptability. The combination of behaviors described reveals great cognitive flexibility. The set of findings from each area can lead to new questions and provide insights into the phenomena expressed in the other area, as will be illustrated.

THE NATURE OF ECHOIC-VISUAL SENSORY INTEGRATION IN THE DOLPHIN
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A fundamental question about an animal's sensory system is the degree of overlap or integration of the central representations provided by each sense. For the dolphin, a central issue is the relation between information from the visual and echoic senses. In earlier research (Herman & Pack, 1992) we examined this relationship in cross-modal tasks. A dolphin was shown capable of rapidly, though not necessarily immediately, recognizing an object through its vision that it had only experienced previously through its echoic sense; the reverse also held: rapid recognition of some objects through the echoic sense that were only experienced previously through vision. Deficiencies in cross-modal recognition were traceable in many cases to difficulties in within-modality recognition, for one sense or the other. In a study to be reported here, only objects shown to be discriminable by each sense independently were used in cross-modal tests. This provided a definitive study of cross-modal capabilities. Sensory integration, as studied here, hints that the mental representation formed through the echoic sense is richly developed and, in many cases, is coordinate with the mental representation formed through vision. Such integration is of obvious benefit in the natural world of the dolphin.

ELEMENTS OF CULTURE AND COGNITION IN THE HUMAN-DOLPHIN COOPERATIVE FISHERY IN LAGUNA, BRAZIL

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In Laguna, dolphins (Tursiops truncatus) drive mullet (Mugil sp.) toward throw-net fishermen and indicate with a stereotyped splash when to throw the nets. For the dolphin, uncaught fish become easy prey. The system has been operating daily (in good weather) for over 100 years. Some evidences of culture are: 1) Many dolphins are in the area, but only one group participates in the fishing; 2) all participants were calves of participating females; 3) three generations of today's fishermen report fishing with the same dolphins and their offspring; 4) dolphins in other areas use a variant splash signal. Evidences of cognition are: 1) the dolphin selects the fishing site; 2) dolphins initiate and control the fishing entirely; 3) dolphins sometimes actively search for fishermen and "invite" them to fish; 4) dolphins adapt their techniques to a variety of prey and circumstances; 4) some dolphins dominate the men and "tease" them; 5) some dolphins continue driving fish for sport when satiated.

THE ROLE OF COGNITION IN NATURAL COMMUNICATION AMONG DOLPHINS.

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Among natural communication signals in delphinds, most is known about the whistles of bottlenose dolphins, *Tursiops truncatus*. Both in the wild and in captivity, individually distinctive signature whistles are a dominant element of the whistle repertoire of most individuals. Adult dolphins have long been known for remarkable abilities to imitate manmade sounds. Dolphin calves in captivity learn to develop a signature whistle that matches either natural or manmade acoustic models prevalent in their natal environment. Some wild dolphin mothers appear to change their whistle after a calf is born, producing a model that the calf imitates. This suggests that mothers may modify the course of whistle development. Mothers and calves in the wild respond more strongly to each other's whistles than to those of less closely related animals. Both wild and captive adult dolphins imitate the signature whistles of close associates; this occurs in contexts that suggest it may function to call or name the appropriate animal. These data taken together suggest that dolphins have a remarkably open communication system. They appear to learn arbitrary signature whistles, learn to associate a signature whistle with the appropriate animal, and learn to call animals by imitating their whistles.

CONCEPTUALIZATION OF CATEGORIES BY BOTTLENOSED DOLPHINS.

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A series of experiments examined the bottlenosed dolphin's ability to group figures together from either a category whose members shared the abstract feature of "symmetry" (a natural category), or a category whose members shared no abstract feature and were associated with each other based on reinforcement contingencies (an artificial category). In the first set of experiments, a dolphin was trained to select the figure from a pair whose features were arrayed symmetrically about a vertical axis. Transfer tests with 11 novel pairs demonstrated that the dolphin had abstracted a concept of symmetry. Further evidence for this concept appeared when the rule controlling performance was reversed with four pairs of figures (i.e., the dolphin was now rewarded for selecting the asymmetric figure). Subsequent transfer tests with 12 of the pairs from the initial experiment showed immediate first-trial reversal. In the second set of experiments, another dolphin was presented with pairings of figures selected from two different categories, "A" and "B." Each category contained two figures whose only commonality was reinforcement contingencies. Reversal tests were conducted to examine if the dolphin had learned to group members of A together and B together. These tests did not provide evidence for spontaneous generalization of reversals from one member to all members of the artificial category.

CAN DOLPHINS RECOGNIZE AN ABSTRACT RELATIONSHIP BETWEEN OBJECTS?

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Two objects may exist in some relationship to each other. A fundamental type of relationship is whether the two objects are the same physically or conceptually. Premack (1983) has argued that the formation of a true, general "same-different" concept (i.e., a concept applicable to any pair of objects) is intrinsically difficult for nonhuman subjects, and is possibly manageable only by apes given special language training. A same-different concept is demonstrated if the members of each pair are presented together, simultaneously, and the classification is accurate. If presented successively, one member first and then the other, as in the typical matching-to-sample paradigm, the animal may then simply judge "familiarity" rather than the more abstract concept of sameness. Data will be presented showing the ability of a bottlenosed dolphin to classify physical "sameness" or "difference" correctly for pairs of objects presented simultaneously, including pairs new to its experience. These findings therefore reveal a capability for forming a true abstract concept. Such a capability has many potential applications in the life of the wild dolphin, including the classification of both physical and social relationships.

SYMPOSIUM: Research and Conservation Efforts with the Vaquita

CHLORINATED HYDROCARBON CONCENTRATIONS IN THE GULF OF CALIFORNIA HARBOR PORPOISE (PHOCOENA SINUS)

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High concentrations of chlorinated hydrocarbon contaminants have been noted in coastal odontocetes from different regions and have been linked to reproductive problems in a number of marine mammals. The Gulf of California harbor porpoise (Phocoena sinus), also known as the vaquita, is restricted to the northern waters of the Gulf of California, México and is considered one of the most endangered cetaceans. Blubber samples of eight vaquitas incidentally caught in gillnets were analyzed for chlorinated hydrocarbons. Relatively low concentrations of total DDT (530 to 9,100 ppb, wet wt.), alpha-BHC (5 to 49 ppb, wet wt.), and PCBs (<40 to 200 ppb, wet wt.) were found in the samples. Other chlorinated hydrocarbon pesticides were not detected. The DDT metabolite DDE was the only compound recovered from all animals. Concentrations of total DDT compounds suggested an accumulation with age in males and a declining concentration in females after reproductive maturity, though the sample size was too small to statistically test these associations. The proportion of DDE to total DDT indicates that the source of the DDT compounds is not from recent applications of DDT. Based on the low concentrations found, chlorinated hydrocarbon pesticides and PCBs do not appear to pose an immediate hazard to the species.

HOW MANY VAQUITA REMAIN? CAN WE MONITOR CHANGES IN POPULATION SIZE?

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From recent quantitative surveys, we estiamte that the present size of the vaquita population is not more than a few hundred animals. Recent surveys have also confirmed that the present distribution of the vaquita is limited almost entirely to the northwest corner of the Gulf of California. Moreover, we show that ship and aerial surveys, no matter how carefully and thoroughly carried out, will be able to detect only large changes in vaquita population size, i.e., statistical power is low. This conclusion has two important implications for conservation. First, small population size is *ipso facto*, sufficient reason to institute protective measures for the vaquita; proof that the population is declining should not be required. Second, any protective measures for the vaquita should be continued even if there is no proof that the population is recovering, because it will be very difficult to demonstrate any increase in population size.

CONSERVATION STRATEGIES FOR THE VAQUITA: LESSONS FROM AND FOR OTHER PORPOISES

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Formulation of an effective conservation strategy for the vaquita, Phocoena sinus, has been hampered by a lack of basic information on the biology of this highly endangered species. Even with a concerted research effort, it is unlikely that we will be able to generate satisfactory estimates of abundance, incidental mortality levels, or vital rates in the near future. The problems faced by the vaquita are not unique, however, and we can draw many useful lessons from experiences with other species, and particularly with other porpoises. Both congeners of the vaquita face similar problems of incidental mortality in commercial fisheries. In all three species of Phocoena these incidental catches occur most frequently in large-mesh gillnets set for demersal fishes. These catches show similar patterns of entanglement suggesting that the causal factors are similar. Despite considerable effort, particularly with harbour porpoises, we still have no effective solution to this problem other than separating fishing effort and porpoises in time and space. The recent announcement of a biosphere reserve in the Upper Gulf of California recognizes that a separation of nets and porpoises is perhaps the only way to ensure the future survival of the vaquita. In turn, this important conservation action should serve as an important lesson for managers facing similar problems with other porpoises.

INCIDENTAL MORTALITY OF THE VAQUITA, PHOCOENA SINUS, IN GILLNET FISHERIES

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Gillnet fisheries in El Golfo de Santa Clara and neighboring fishing camps, in the upper Gulf of California, México, were monitored daily from 23 January to 7 August 1993, to estimate the rate of incidental mortality of the vaquita. Data on fishing effort and vaquita deaths were collected by interviewing fishermen on the beach when returning from fishing, and by placing observers on different vessels each working day. At least 13 vaquitas were killed in an estimated 15,000 hours of fishing effort: 5-6 in gillnets (mesh size of 10-11 cm) set for chano, Micropogonias megalops; 3 in gillnets ("chinchorro de linea," mesh size of 7 cm) for shrimp, Penaeus spp.; 2 in gillnets (mesh size of 15 cm) for sharks; and 1 in a gillnet (mesh size of 7.6 cm) for mackerel, Scomberomorus spp. Another vaquita was killed in a commercial shrimp trawl. The decomposed carcasses of two more vaquitas (cause of death unknown) were collected from the beach. Most previous records of vaquitas documented to date are from fisheries using large-mesh gillnets (15-30.5 cm) (i.e., totoaba, Totoaba macdonaldi, and several species of sharks and rays). However, as the present data demonstrate, the endangered vaquita is also being caught in smaller-mesh gillnets. Overall incidental mortality may be higher than originally estimated (ca 35/year) since these nets are utilized throughout the range of the vaquita in the upper Gulf of California.

LIFE HISTORY OF THE VAQUITA, PHOCOENA SINUS

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Life-history samples and data from vaquita were examined and analyses conducted for age structure, growth, and reproduction. The majority of the specimens were collected from 1985-1993, and are in the collection at ITESM; teeth and data from additional specimens were obtained from museum collections in the United States. Gompertz curves fit to size-at-age data gave, for females and males, respectively, asymptotic lengths of 140 and 136 cm, asymptotic masses of 44 and 42 kg, and asymptotic girths of 88 and 87 cm. The age structure of the sample was bimodal, comprised mainly of specimens less than 3 years of age and greater than 10 years of age. The oldest individuals were 21 years of age. Ovulation rates appear to be less than once per year and some of the ovaries contained unusual calcified corpora. It does appear as though the sample may be biased to some unknown extent. Nonetheless, the unusual age structure, apparently low reproductive rate, and possible ovarian pathology suggest that the low abundance of vaquita may be compounded by low reproductive success.

GENETIC VARIATION, OR LACK THEREOF, IN THE VAQUITA

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In an effort to investigate the genetic population structure of the vaquita, we have sequenced portions of the control region of the mitochondrial DNA molecule. This region has been found to be highly variable and has proven useful in studies of population structure in a wide variety of mammalian species, including cetaceans. To date, a 400 base pair portion of the control region from 15 individuals and 200 base pairs from an additional 10 animals has been sequenced. No sequence polymorphisms were found among the first 15 animals examined, despite being collected at diverse times and locations within the northern Gulf of California. This contrasts significantly with the genetic variation found in the same region in other phocoenid species. Such a finding may represent the results of a population bottleneck, founder effect, or severe inbreeding in a species with a very small effective population size.

SEXUAL DIMORPHISM AND ALLOMETRIC GROWTH IN THE SKULL OF THE VAQUITA, PHOCOENA SINUS, AND COMMENTS ON THE POSTCRANIAL SKELETON

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We studied 25 skulls and 29 postcranial skeletons of vaquita, Phocoena sinus, to determine if sexual dimorphism and allometric growth exist. Neonates, immatures and adults of both sexes were present in the sample. A total of 124 cranial measurements were taken from each skull, with sexual dimorphism indicated for only five (utilizing t-test [matched pairs]): height of left premaxillary boss, width of foramen magnum, height of mandible at subapical swelling, width of left occipital condyle and length of right pterygoid. The first four are larger in females while the fifth is larger in males. Sexual dimorphism is also present in the shape of the basihyal. Correlation analysis indicated six characters that do not change during development: nasal width, total length of pterygoid, length of periotic, length of tympanic cavity, and width and height of left premaxillary boss. All of the other cranial characters show slow growth. Compared to other porpoises, the vaquita shows the greatest paedomorphism (i.e., several fetal or juvenile characters which persist in adults), principally in the cranial vault and pterygoid thicknesses. Also, the forelimb of the vaquita has only three carpals, while other phocoenids have five or six. The presence of a variously developed "sixth digit" (from the third metacarpal) was noted in the flippers of all animals (25) examined.

THE ENDANGERED VAQUITA, PHOCOENA SINUS, AND IT'S RECOVERY PERSPECTIVE

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Vaquitas are caught and killed incidentally in the totoaba gillnet fishery. Totoaba exploitation was excessive and nearly brought the species to extinction. The size of the vaquita population before the beginning of the totoaba fishery is unknown. However, as the totoaba fishery grew so did the incidental take of vaquita. In recent years, knowledge of the vaquita has grown, and the scientific community and the general public have become increasingly aware of the problems involving the species. In early 1992, the Mexican Government established the Technical Committee for the Preservation of the Totoaba and the Vaquita. On June 10, 1993, the President of México inaugurated a new biosphere reserve recognized as the "Upper Gulf of California and Colorado River Delta."

SYMPOSIUM:
Steller Sea Lions

PREY SELECTION IN STELLER SEA LIONS IN THE GULF OF ALASKA.

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Steller sea lion prey were studied in the Gulf of Alaska during the period 1975-79 and again during 1985-86 by collecting animals and determining contents of stomachs. Two hundred and forty one stomachs were examined; one hundred fifty three in 1975-79 and 88 in 1985-86. Contents were removed in the field, weighed and examined. Hard parts were examined in the laboratory and identifications were made to the lowest taxon possible. In both periods sea lions ate a wide variety of fish and cephalopods. Walleye pollock (*Theragra chalcogramma*) was the most important prey item in the diet in both 1975-79 and 1985-86 collection by combined rank index (CRI). Squids (Gonatidae), Pacific herring (*Clupea harengus*), capelin (*Mallotus villosus*), Pacific cod (*Gadus macrocephalus*) and Pacific salmon (*Onchorhynchus* sp.) ranked 2 through 6 respectively in 1975-79 by CRI. Octopus (*Octopus* sp.), flatfishes (Pleuronectidae), Pacific cod, Pacific sand lance (*Ammodytes hexapterus*) and Pacific salmon were ranked 2 through 6 respectively in 1985-86. Some differences in ranking by area were noted. Pollock occurred in 2% of the stomachs examined in the 1960's, 66.7% in the 1970's and 41% in the 1980's. Both the range of sizes and the mean size of pollock consumed by sea lions in 1985-86 was significantly smaller. Mean weight of individual pollock consumed in 1985-86 was 37% smaller. Larger sea lions generally fed on larger pollock.

PHYSIOLOGICAL HEALTH STATUS OF STELLER SEA LIONS AND OTHER PINNIPEDS IN ALASKAN WATERS: PROGRAM OBJECTIVES.

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The population declines of pinniped species in the Gulf of Alaska and nearby waters is well documented. However, the source of the decline is ambiguous. Our project, in cooperation with the National Marine Mammal Laboratory, the Alaska Department of Fish and Game, Texas A&M, and private consultants, involves developing and utilizing *condition indices* of pinniped health to examine the resident populations. For example, with Steller sea lions, most population biology studies have suggested that recruitment of juveniles is depressed. We proposed that we study the newborn pups and assess their general health status. We asked: "If the young are not surviving to adulthood, are they severely compromised in their first month of life?" On the basis of blood chemistries, body condition, growth rates and appearance, it does not appear as if the pups are being removed from the population before they are weaned. Our results suggest that the critical stage for this species must be occurring at the post-weaning level. We are applying these theories and indices to a broad range of pinnipeds in areas of both decline and population growth to test our hypotheses.

FEMALE REPRODUCTIVE EFFORT AND PUP GROWTH IN STELLER SEA LIONS

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Indices of adult female reproductive effort and pup growth were studied on Alaskan Steller sea lions. Data from declining populations at Chirikof (CI) and Marmot (MI) Islands were compared to a stable population at Lowrie I. (LI). Trip duration of adult females was monitored by attaching transmitters to their backs; known-age pup growth and body condition were measured during their first 40 days. Mean trip duration (21.4 hrs) was not significantly different for females on CI and LI. There was no significant difference in mean birth weight (20.5 kg) of pups at CI and LI, although males (21.8 kg) were larger on average than females (18.6 kg). Pups grew linearly at the same rate at CI and LI, but were heavier on CI during the first 40 days. Male and female pups gained weight (0.4 kg/day) at the same rate, but males remained consistently heavier than females. Preliminary data indicate that the smallest and leanest pups occur on MI. Additional data is needed to account for inter-annual variation at the study sites.

HOW THE THREATENED STATUS OF THE STELLER SEA LION HAS AFFECTED FISHERIES MANAGEMENT OFF ALASKA

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Prior to the final listing of Steller sea lions as a threatened species under the U.S. Endangered Species Act (ESA) on 26 November 1990, groundfish fisheries off Alaska were principally managed by standards and regulations established under the U.S. Fishery Conservation and Management Act and the U.S. National Environmental Policy Act. However since the listing, ESA Section 7, which requires that any federal action not jeopardize the continued existence of a listed species, has become increasingly important in fisheries management and has lead to several specific management actions. For instance, in 1991 NMFS concluded that spatial and temporal concentration of trawl fishing for pollock in the 1980s in areas inhabited by sea lions could have contributed to their population decline. This conservative and general conclusion drawn from analyses of fishery statistics and sea lion population biology formed the basis of several management actions designed to both disperse trawl fishing effort in space and time and separate it from sea lions, including spatial allocation of the Gulf of Alaska pollock harvest and trawl exclusion zones around rookeries.

Section 4 of the ESA requires the designation of critical habitat for threatened species, which contains those features essential to the species' conservation, and which may require special management consideration or protection. While designation of Steller sea lion critical habitat (scheduled for summer 1993) does not, in and of itself, prohibit any activity, each federal agency must insure that its actions within critical habitat will not destroy it or adversely modify its usefulness to sea lions.

COMPARATIVE ASPECTS OF MALE BREEDING BEHAVIOR IN THE STELLER SEA LION (*EUMETOPIAS JUBATUS*)

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All sea lions are polygynous, sexually dimorphic and territorial. Breeding behavior in sea lions has evolved in response to the constraints of land breeding and the gregariousness of females, which promotes differential reproductive success in males. Male sea lion breeding behavior varies between species and appears to be flexible. Territorial behavior and reproductive success are determined by the length of the breeding season, spacing of females, timing of estrus, and thermoregulatory needs.

Steller sea lions studied at Año Nuevo Island, CA, have a six week pupping period during which females are extremely gregarious. Males maintain historically defined territories, which after initial possession, are rarely contested physically. Males never leave their territories during the breeding season and copulate with an average of seven females. In contrast is the Australian sea lion, with a five month pupping period in which females are non-gregarious and differential reproductive success of males is low. Male territories are plastic in time and space and reflect the temporal and physical spacing of the females. Between these extremes are the California and South American sea lions.

At Año Nuevo Island, the declining Steller sea lion population has resulted in a contraction of breeding areas and maintenance of high female density. Males have abandoned some of the previous breeding sites in response to female pupping site preferences. As in other sea lion species, male Steller sea lions are constrained to adapt their behavior to female biology and behavior.

FOOD OF STELLER SEA LIONS IN THE ALEUTIAN ISLANDS, 1990-91.

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Recent population declines of Steller sea lions (Eumetopias jubatus) have been hypothesized to be caused by changes in the abundance and/or quality of their preferred prey. However, few data are available on the food habits of this species in the Aleutian Islands (AI), the area formerly the center of the species' range. Scats were collected annually (>100 per year) during 1990-1993 by NMFS and USF&WS at rookeries and haul-outs in the area between Ugamak Island (in the eastern AI) and Agattu Island (in the western AI) during both summer and winter. These materials were sieved in the laboratory, hard parts (e.g., bones) removed and dried, and prey identifications made. For the summers of 1990-91, 163 samples were analyzed which contained identifiable contents. Of these samples, 149 (91.4%) contained Atka mackerel (Pleurogrammus monopterygius) of which 114 (69.9%) contained only Atka mackerel. The only other species commonly found were walleye pollock (Theragra chalcogramma; n=20 or 12.3%) and salmon (Oncorhyncus sp.; n=21 or 12.8%). The dominance of Atka mackerel in the diet was common throughout the AI and increased from 69.6% (16 of 23 samples) in the eastern AI to 91.0% (61 of 67 samples) in the central AI and 98.6% (72 of 73 samples) in the western AI. The proportion of scats containing pollock remains decreased in a similar fashion from 17.3% in the east to 8.2% in the west. There is little data on the historical importance of Atka mackerel as a prey item. The one AI site where comparable data exists prior to 1990 (Ugamak Island in the eastern AI) had no mackerel remains in 11 scats collected in 1985, although all contained gadid remains. By 1991 mackerel was found in all 10 scats collected, but only 1 had gadid remains. This shift parallels large changes in mackerel and pollock biomass which occurred during 1983-91.

A VIABILITY ANALYSIS FOR THE ALASKAN STELLER SEA LION POPULATION

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The worldwide population of the Steller sea lion (*Eumetopias jubatus*) declined more than 50% between the late 1960's and 1989; numbers in Alaska continued to decline through 1992. The species was listed under the U.S. Endangered Species Act in 1990 as threatened rangewide. We describe a population viability analysis prepared to evaluate the potential for extinction of the Alaska population. Three models were developed based on the stochastic model of exponential growth of Dennis et al. (1991) and the 1985-92 population trend. Two of the models (an all Alaska model and a Kenai Peninsula-Kiska Island model) were based on the trajectory of the sum of the rookery populations within their respective areas. A third was based on a simulation of the population trajectories of individual rookeries in the Kenai-Kiska area. All three models predicted the Alaska population will be reduced to levels approaching extinction within 100 years from the present, if the 1985-92 trend persists into the future. Both the all Alaska and Kenai-Kiska models predicted the probability of extinction near 1.0 at 100 years; mean times to extinction were 75 and 60 years, respectively. The individual rookery simulation predicted a longer time to extinction due to the persistence of small populations on several rookeries; however, the probability of extinction was still greater than 0.10 at 100 years. Results indicated that, if the 1985-92 trend persists, the next 20 years may be crucial to the survival of the Alaska population. Populations on most rookeries would be reduced to low levels (mean size may be less than 100 adult females). After 20 years, rookeries would begin to disappear as the population contracts to the core of the range in the western Gulf of Alaska and eastern Aleutian Islands. After most rookeries have been vacated, extinction probabilities will increase rapidly. Thus, if the 1985-92 trend persists, in 100 years the only Steller sea lions remaining in the U.S. may be in the area between southeastern Alaska and northern California; if the more moderate recent (1989-92) trend continue, then mean times to extinction would be significantly longer (i.e., 148 for Alaska and 207 years for Kenai-Kiska).

STELLER SEA LION POPULATION STATUS AND TRENDS

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A 1989 range-wide survey of Steller sea lions (Eumetopias jubatus) suggested that the world population was about 116,000, 39-48% less than during the 1960s. Recent aerial and ground surveys of adults, juveniles, and pups show that the population is continuing to decline in most of Alaska, but that populations in Oregon and British Columbia are unchanged. In Alaska, a total of 34,844 adult and juvenile sea lions were counted in 1992 at 95 trend sites, representing a decline of 70.2% from 1979 (116,804) and 4.4% from 1991 (36,459). Estimated annual rates of decline for 32 Alaskan rookeries were 10.2% (P<0.001) for 1979-92 and 5.4% (P=0.06) for 1989-92. Pup counts at 15 Alaskan rookeries declined at 8.2-10.7% yr^{-1} during 1990-93. One new and two old Alaskan rookeries were established during the 1990s. Counts at other eastern Pacific rookeries are similar to those reported in 1989. Data are unavailable for the western Pacific Ocean rookeries. A second range-wide survey is planned for 1994.

FORAGING BEHAVIOR OF ADULT FEMALE AND YOUNG-OF-YEAR STELLER SEA LIONS IN ALASKAN WATERS.

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One explanation for recent declines in the Alaskan Steller sea lion (Eumetopias jubatus) population is that it is due to reduced availability of preferred prey. Part of our evaluation of this hypothesis involves the use of satellite-linked time-depth recorders (SLTDR's) to study foraging areas, depths, and effort by season for adult female and young-of-year Steller sea lion (Eumetopias jubatus). Instruments were deployed during 1990-93 at rookeries and haul-outs throughout the Gulf of Alaska and eastern Aleutian Islands. Where possible deployments occurred at the same site in winter and summer, and with both adult females and young-of-year in winter. Animals were first anaesthetized using Telazol, and the SLTDR was then glued to the back of the sea lion using fast setting five-minute epoxy. A total of 43 SLTDRs were deployed, 24 of which provided useful data--10 on adult females in summer, 9 on adult females in winter, and 5 on young-of-year animals in winter. During summer, adult female Steller sea lions with pups forage close to land (within 20 km), make brief trips (< 2 days), and dive to shallow depths (< 30 m). However, in winter trips by adult females post weaning are much longer in distance (> 300 km offshore) and duration (up to several months). Dives are also deeper (often > 250 m). Sea lion pups by their sixth month are able to range more than 300 kilometers in a trip, although most of their dives remain shallow (< 20 m) and brief (< 1 min). From these data we conclude that adult female sea lions can exploit prey from throughout much of the Gulf of Alaska and Bering Sea ecosystems; however, young-of-year sea lions appear more restricted in their foraging depths. As such, young sea lions would be more vulnerable to changes in the vertical distribution of their prey, and could be more easily food limited.

BEHAVIORAL AND POPULATION ECOLOGY OF STELLER SEA LIONS: A COMPARATIVE APPROACH

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The elucidation of the proximal factors responsible for the decline of a species is difficult unless extensive pre-decline data exist with which to compare. In the absence of a large data base, comparison between sites with differing ecological histories may help determine which aspects of the animal's biology is affected, and therefore, what types of changes have contributed to the decrease. Although the Steller sea lion (*Eumetopias jubatus*) has undergone a 50% range wide reduction, the distribution of decline has not been uniform. This study compares behavioral and population parameters for Steller sea lions residing in three different locations: (1) Año Nuevo Island, central California, the southernmost breeding site which suffered an 80% decline between 1960 and 1980, but appears to have stabilized over the last 10 years. A relatively good historical database exists for this population; (2) Marmot Island, Gulf of Alaska, mid-range for this species, has undergone a 70% decline in the last 10 years. This population has also been the subject of several studies, and (3) Lowrie Island, southeastern Alaska, has increased 14% in the last 8 years. Other than census counts, there have been few studies performed on this population.

At all three sites, activity budgets, responses to thermal regime, female feeding cycles, suckling rates, fecundity, and copulation rates, as well as other population parameters were studied.

The Decline of Steller Sea Lions and the Development of Commercial Fisheries in the Gulf of Alaska and Aleutian Islands

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The goal of our study was to estimate the total population size of sea lions in Alaska and develop a simulation model to explore the role that harvesting and incidental kills by fisheries may have played in the decline of Steller sea lions. We also attempted to relate the population declines to the amount of fish caught near sea lion rookeries and to the number of vessels fishing from 1950 to 1990. Using life tables to estimate population size, the numbers of sea lions were estimated for all rookeries for which information was available in each of six areas in the Gulf of Alaska and Aleutian Islands. The total population appears to have risen from 150,000 to 210,000 from the mid 1950s to 1967. The population was then stable for roughly ten years, then increased to 225,000 by 1979. Since then it has decreased to about 85,000. Most of the decline took place in Area 3 (Kodiak region) but there were also significant declines in Areas 4 to 6 (westward of Kodiak). Increases have occurred in the smaller populations of Areas 1 and 2 (southeast Alaska and Prince William Sound). A major growth in domestic fisheries occurred after the declaration of 200 mile zones. The traditional fisheries for salmon, herring and halibut were augmented by major groundfish fisheries. The decline in the numbers of sea lions has been coincidental with the growth in the numbers and size of vessels and the increase in catch. The stabilization in the numbers of sea lions in the Gulf of Alaska from 1956 to 1980 can be attributed to the direct effect of incidental capture in fishing gear, the shooting of sea lions and the harvesting of adults and pups. However, these factors explain but a small portion of the recent population decline, from 1980 to the present. Some sea lions are missing in the arithmetic of population dynamics which cannot be accounted for by movements of animals from one area to another. Whether these losses are caused by the removal of food resources is a circumstantial possibility, but evidence of local abundance of food resources at particular times of the year for particular segments of the population is needed to build a convincing case. Other causes, such as diseases and parasites must also be kept in mind as possible contributing factors.

THE RELATIONSHIP BETWEEN BODY CONDITION AND THERMOREGULATORY COSTS IN STELLER SEA LION PUPS

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The energetic cost of thermoregulation in pinnipeds often depends on the thermal characteristics of an insulating layer of blubber. In this study, we examined the quality and quantity of blubber in Steller sea lion pups, and assessed their effect on heat loss and thermal costs. Skinfold thickness (ST, an index of blubber thickness), heat flow, and skin temperature were measured for six different anatomical sites. Data were collected on pups from three islands in Alaska: Marmot (n = 11 pups), Lowry (n = 38) and Chirikof (n = 22) Islands. ST was positively correlated with mass (r = 0.65, n = 71), where

Skinfold thickness (mm) = 0.50(mass in kg) + 1.75.

Body mass, regional heat flow, and skin and rectal temperatures were similar for known age pups from Lowry and Chirikof Islands. In comparison, Marmot Island pups had smaller skinfold thicknesses coincident with lower body mass. Insulating quality of the blubber was also lower in these pups. As a result, the thermal energetic costs calculated for Marmot Island pups were higher than values for Steller pups from the other two rookeries.

CONTRIBUTED PAPERS

DIET PREDICTION OF THE LONG-FINNED PILOT WHALE (*GLOBICEPHALA MELAS*) USING CARBON AND NITROGEN STABLE ISOTOPE TRACERS.

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The question of whether long-finned pilot whales are actively targeting a single species or are feeding on whatever is available has yet to be determined. Stable isotope measurements have been previously used to trace the diets of birds, mammals, and fish and can indicate the short and long-term diet of an animal. The carbon isotope ratios $^{13}C/^{12}C$ indicate the ultimate source of the diet, whereas the nitrogen isotope ratios $^{15}N/^{14}N$ reflect the trophic level.

Carbon and nitrogen stable isotope ratios were determined for skin, muscle, and blubber of three female long-finned pilot whales incidentally taken in the Mid-Atlantic Bight foreign mackerel fishery and three female long-finned pilot whales stranded on Cape Cod. Stable isotope values were also determined from known prey sampled from the surrounding geographic areas. Combining a diet model with estimated turnover rates of the three tissues, I predicted the diets of these whales. The short-term indicator skin, predicted a mixed diet of Atlantic mackerel (*Scomber scombrus*)and long-finned squid (*Loligo pealei*). But the muscle and blubber predicted a medium and long-term diet of long-finned squid.

EFFECTIVENESS OF AN ENVIRONMENTAL ENRICHMENT DEVICE IN IMPROVING THE WELL-BEING OF CAPTIVE PACIFIC WHITE-SIDED DOLPHINS AND PACIFIC HARBOR SEALS

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An eight-keyed apparatus was made available to a group of captive marine mammals, two female Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and three female Pacific harbor seals (*Phoca vitulina richardsi*). This device allowed the animals to request any of eight reinforcers (fish, tactile stimulation, a surface water jet, a ring, a ball, dolphin sounds, classical music, or popular music) each of which corresponded to one of the keys. The apparatus was made available to the animals three days per week, for two 25-minute sessions. Baseline behavioral data were collected for each of the animals for comparison to behavior of the animals during experimental sessions. Two separate studies were done, one in which behavioral data was collected by focal group sampling, and a second one using focal animal sampling. Data were also collected on usage of the apparatus.

All animals were seen to use the apparatus. Use of the apparatus did not decrease significantly over time. Key 1, fish, was the key most often pressed during group sessions. Two of the five animals, one dolphin and one seal, accounted for 80% of the key presses. Increased time spent in active behavior, decreased frequency of agonistic behavior, and decreased frequency of wall-touching (a stereotypic behavior seen only in the dolphins) were used as indicators of increased well-being. Analysis of behavior showed evidence of increased well-being for the dolphins in the experimental sessions, according to all of the above behavioral measures. The seals' behavior showed no evidence of any changes in any of the behavioral measures. Behavioral evidence supported the hypothesis that availability of this apparatus had a significant positive effect on the well-being of the dolphins; however, availability of the apparatus apparently had no significant effect on the well-being of the seals.

ASPECTS OF BIOLOGY AND POLLUTANT LEVELS IN HARBOUR PORPOISES *PHOCOENA PHOCOENA* (L.) STRANDED ON THE DUTCH COAST, 1990-1993.

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Blubber, liver and kidney samples of ca. 30 stranded harbour porpoises from the Dutch North Sea have been analyzed for organochlorine contaminants such as pesticides and PCB's. Levels of dioxines and planar PCB's were also determined within a subsample. The results will be compared with pollution levels in stranded and bycaught porpoises from other parts of the North Sea.

Moreover, the relation to parameters like age, reproductive status and length/weight ratio were investigated. One striking aspect is the predominance of immature females in the sample. Association between the degrees of pollution and biological aspects will be discussed.

THE EFFECTS OF PHOTOGRAPHIC MATCHING ERRORS ON POPULATION ESTIMATES OF FIN WHALES USING CAPTURE-RECAPTURE DATA

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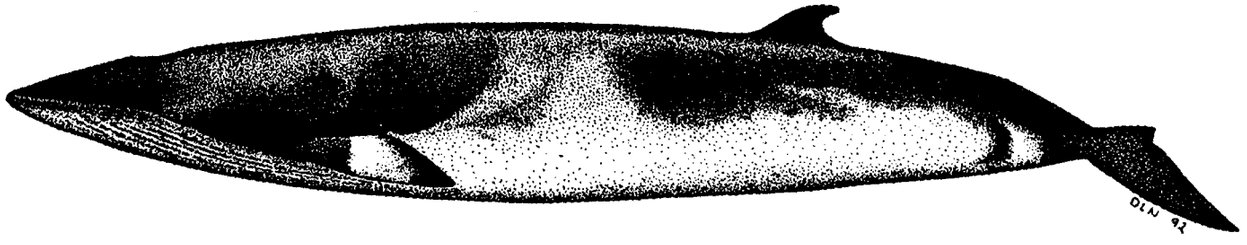
This paper uses the correction factors developed by Agler (1992) to evaluate the effect of re-identification errors on the Petersen estimate when estimating population size of fin whales (Balaenoptera physalus). I also examine the effects of sample size and the number of resightings on a population estimate. Corrected estimates were consistently lower than those given by the Petersen estimate and the Bailey's binomial model when resighting rates were < 60% of the second sample (120 individuals). Differences between the corrected and uncorrected estimates were affected more by the number of resightings than by the actual number of individuals sampled. When the resighting rate was less than 15% of the second sample (30 individuals), the difference between the corrected and uncorrected population estimates increased markedly. When the number of resightings was reduced from 5% (10 individuals) to 2.5% (5 individuals), the corrected estimate increased by only 16%, while the Petersen estimate increased by 50%. Thus, when resighting rates were ≤ 5%, the Petersen estimator differed from the corrected estimate by 78-81%. This poses a problem for many marine mammal researchers who use these models, because resighting rates often are low. Differences among estimates by observers' experience level reinforce the need to use experienced observers only. Inexperienced observers made more errors, which caused them to underestimate population size at resighting rates ≤ 50-60% (100-120 individuals) and overestimate population size at higher rates, when compared with experienced observers. The increased variability in scores among inexperienced observers caused the upper and lower estimates to be much wider than those found for experienced personnel.



GROWTH AND MATURITY PARAMETERS OF WESTERN MEDITERRANEAN STRIPED DOLPHINS (Stenella coeruleoalba)

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Seven biological parameters associated with growth and maturity were determined for the striped dolphin population inhabiting the western Mediterranean and compared with the eastern Atlantic and Japanese populations. Parameters examined were: maximum body length, extent of sexual dimorphism, age at sexual maturity in females, length at birth, age at fusion of vertebral epiphyses, age at fusion of nasal bones, and age at fusion of distal rostrum. Length-associated parameters were obtained from published stranding records of striped dolphins from the whole western basin, while age-related parameters were calculated from a sample of 120 dolphins collected off the eastern coast of Spain. Growth and maturation rates were found to be much lower for the Mediterranean population than for the Japanese one. Body length and length at birth were smaller in the western Mediterranean, intermediate in the eastern Atlantic, and largest in Japanese waters. However, relative to body length, length at birth remained constant at about 42% for the three populations. Food availability and density-dependent factors probably explain the geographical differences observed.

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DIGITAL SIGNAL ANALYSIS OF WEDDELL SEAL VOCALIZATIONS FOR INDIVIDUAL IDENTIFICATION.

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We have begun work using computer enhanced digital signal processing (DSP) to analyze marine mammal vocalizations. Digital signal processing entails the break down of the original speech waveform into simpler sinusoidal waves. This break down allows for a more detailed analysis of animal vocalizations including individual identification. Antarctic Weddell seals (*Leptonychotes weddellii*) are very vocal animals, having the largest repertoire of calls in the pinniped family. Several hours of Weddell seal recordings were taken during the 1993 Antarctic spring field season in the McMurdo Bay area. Recordings were made using a Nagra IV recorder and analyzed using a Kay Elemetrics time frequency system. Digital analysis of the recordings and technical aspects of applied DSP will be presented.

GENETIC EVIDENCE FOR SITE FIDELITY OF BREEDING GREY SEALS AT TWO BRITISH SITES: NORTH RONA AND THE ISLE OF MAY

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Microsatellites comprise tandem repeats of very short motifs (1-5 nucleotides in length) which occur abundantly throughout all eukaryotic genomes. Such sequences are prone to a process termed slippage, which has the net result that microsatellite loci exhibit high levels of length variability. Microsatellite polymorphism can be quantified by polymerase chain reaction (PCR) amplification, the products being resolved to single nucleotide resolution on polyacrylamide sequencing gels.

Microsatellites are increasingly being used as genetic markers to assess behavioural strategies and social organisation in wild populations. A number of microsatellite loci have been cloned from grey and common seal DNAs. Four of these loci have been used to screen 250 grey seals from each of two breeding colonies; North Rona, off the north-west coast of Scotland, and the Isle of May, situated at the mouth of the Firth of Forth on the east coast. Radio- and satellite-tracking of individual animals has demonstrated that adult grey seals range widely outside the breeding season, indicating that movement between the two study sites, separated by approximately 500km, is within their capabilities. Interchange of individuals between colonies during the breeding season would result in considerable gene flow and hence genetic homogeneity. Results from this study, however, show significant allele frequency differences between the two populations for 3 of the 4 loci studied. Such genetic differentiation implies that there is little interchange of animals between the two sites, resulting in limited gene flow. This could be explained either by a major east-west population sub-division or by strong fidelity of both sexes to their natal breeding site/colony.

SPATIAL PATTERNS IN MARINE MAMMAL DISTRIBUTION AND ABUNDANCE IN THE GULF OF THE FARALLONES

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Marine resource managers increasingly require sophisticated methods to analyze abundance and spatial distribution of marine mammals and to assess the effects of human activities. A geographic information system (GIS) is a powerful tool for analyzing spatial relationships. Our objectives were to 1) map marine mammal distribution and abundance in the Gulf of the Farallones based on at-sea surveys, 1985-1991, and 2) characterize the ecological relationships of marine mammal distribution/abundance and environmental variables. Results indicate that persistent physical features (eg. depth, distance to land) best explain spatial variability; we detected segregation of species along the continental slope, outer shelf and nearshore. We then designed predictive models of distribution and abundance using GIS and tested the model accuracy with data collected in 1992. We applied the results of the predictive models to coastal zone management issues such as the location of offshore dredge spoil dumpsites.

POPULATION CHARACTERISTICS OF A WINTER REFUGIAL MANATEE (TRICHECHUS MANATUS) POPULATION AT HOMOSASSA SPRINGS, CITRUS COUNTY, FLORIDA: 1982-1993

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Observations of manatees congregating in the Blue Water Run (BWR) portion of Homosassa Springs, Fl. were made during the winters of 1982-1993. This site has previously lacked the detailed studies necessary to determine if sanctuary status is warranted. Instead, it has been considered a component of the Crystal River refugium, located ten miles north of the site. Surveys were made with snorkel to record scar patterns by taking underwater photos, video, and scar drawings. Data were enterd into a scar catalog at the Florida Institute of Technology. Of the 977 recorded sightings of manatees, 513 were identified and 209 were entered into the catalog as individuals.

Chi-Square analysis was used to determine if differences between the observed population parameters was significant. Swimming (35.1%) and bottom resting (32.9%) were the most frequently observed activity, while feeding (8.6%) and reproductive behavior (4.2%) were least likely to be observed, suggesting that manatees in the BWR are reserving energy and resting. Males accounted for 43.3% of the population, while 49.7% were females. The major component of the population consisted of adults (52.8%) with healing or healed scars. Juveniles made up 43%, while calves contributed to 6%. Resident animals accounted for 20% of the population, while transients made up 80%. Of the individual manatees observed, 26% were recorded in the BWR in more than one year. This shows that manatees are returning to this refuge on a yearly basis. These data support the recommendation that Homosassa Springs be designated a distinct winter manatee sanctuary.

LIFE HISTORY OF FRASER'S DOLPHIN BASED ON A SCHOOL CAPTURED OFF THE PACIFIC COAST OF JAPAN

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We describe life history variables of Fraser's dolphin (*Lagenodelphis hosei*), a little known delphinid species, based on a school captured by the driving fishing method in Japan. A mixed school of about 1,000 Fraser's dolphins and melon-headed whales was driven to Taiji, Wakayama Prefecture, on 29 January 1991, and a third of the animals in school were killed. We examined 110 Fraser's dolphins and tried to estimate some life history parameters, though the data were from only one school and some sampling bias was inevitable. The sex ratio was almost 1:1 and mature dolphins of both sexes were most prevalent. The school structure corresponded to that of a non-mating mature school of striped dolphins. Based on the dental GLG inspection, the oldest animals were two males and a female of 17.5 yr. Age and body length at sexual maturity were estimated at 7-10 yr and 220-230 cm in males and 5-8 yr and 210-220 cm in females. Mature males were larger in body length than mature females and showed apparent secondary sexual features; deepening of tail stocks, and widening and darkening of lateral black bands. The annual ovulation rate was 0.49. Gestation period calculated from length at birth (110 cm) was about 12.5 months and the calving season is thought to occur in spring and probably also in fall. The reproductive cycle of females was estimated to be about 2 yr. These life history parameters of Fraser's dolphin are comparable with those of striped and spotted dolphins in the western North Pacific, except for longevity. The reproductive rate of this species may be lower than other pelagic delphinids, if the observed shorter longevity is real.

A MOLECULAR ANALYSIS OF MALE MATING SUCCESS AND SHARED PATERNITY IN THE GREY SEAL

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Grey seals breed colonially at remote sites around the British Isles and elsewhere. Within the breeding colony males compete aggressively for access to the more numerous females. We have used DNA fingerprinting in order to investigate male reproductive success and whether the considerable site fidelity shown by both sexes results in the production of full sibs. Amongst 133 mother-pup pairs tested against 70 males we found that although dominant males gain more paternities than subordinates, their monopoly is not as great as their domination of mating opportunity suggests. This may be either because of sneaking by subordinates or because some females are fertilised outside the breeding colony. Comparing the DNA fingerprints of pups born to the same female in different years we found that some 30% were full sibs. Much, but not all of this can be accounted for by parental site fidelity.

NEW REALISTIC ESTIMATES OF POLAR BEAR SURVIVAL

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Annual adult survival rates in the high 90 percentile range appear necessary to sustain population sizes of polar bears (*Ursus maritimus*) and other large mammals with phlegmatic reproduction. Past estimates of survival rates for adult polar bears have been between 0.85 and 0.93, with most in the middle 80 percentile range. These estimates fall far short of necessary survival rates! Prior efforts at modeling polar bear population dynamics have been severely hampered by the persistent need to arbitrarily "upgrade" survival rate inputs for adults. Under sampling of newborns and absence of a measure of total litter loss also have meant that past estimates of early survival in polar bears were compromised. In an attempt to derive realistic estimates of survival for adult polar bears and dependent young, we fitted 304 adult female polar bears with radio transmitting collars between 1981 and 1992. Instrumented bears were periodically revisited to ascertain their status and the status of their accompanying cubs. Data were analyzed with the staggered entry modification of the Kaplan-Meier survivorship model. The annual survival rate estimated for adult female polar bears was 0.973 with a 95% CI of 0.956-0.986. Cub survival from den emergence to weaning was 0.676 (0.636-0.704). These unbiased and realistic survival rates will be invaluable new inputs into population projection and analysis models.

THE BRYDES WHALE, *BALAENOPTERA EDENI* ANDERSON 1878: DISTRIBUTION IN THAI WATERS WITH REMARKS ON OSTEOLOGY

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Eight nearly complete skeletons of baleen whales originating from the Gulf of Thailand and the Andaman Sea were examined and identified as Brydes whales (*Balaenoptera edeni*) based on the characters reviewed by Omura et al. (1981). The material included specimens earlier referred to as minke (*B. acutorostrata*) or sei whales (*B. borealis*) by Lekagul & McNeely (1977). The Brydes whale hence is the only rorqual positively identified from Thai waters.

Two specimens less than 9 m long had epiphyses unfused and were regarded as immature, one specimen of unknown length was intermediate whilst five specimens 9 m long or longer had fused epiphyses and were regarded as mature animals. The vertebral formulae was C 7, D 11-13, L 10-13, Ca 8+ - 17+ = 39+ - 48+. There were between 3 and 5 double headed and between 8 and 10 single headed ribs on each side. Skull and bone measurements of adult Thai specimens were found to be intermediate between offshore Brydes whales reported by earlier researchers and minke whales, and are believed to belong to the coastal form of the Brydes whale (in sensu Best 1974).

METABOLIC AND CARDIOVASCULAR ADJUSTMENTS TO DIVING IN NORTHERN ELEPHANT SEALS (MIROUNGA ANGUSTIROSTRIS).

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Our observations of repetitive long duration dives and instances of profound bradycardia during such dives suggest that metabolic adjustments may accompany the cardiovascular ones to maximize oxygen conservation and increase underwater endurance. Therefore, the at sea energy consumption, dive depth, swim velocity, heart rate, and body temperature of translocated juvenile elephant seals were measured using ^{18}O doubly labeled water and purpose-built data loggers. Mean dive statistics were: duration, 15 min.; surface interval (SI), 1.7 min.; dive heart rate (HR) 40 beats per min. (bpm); SI HR, 108 bpm; swim speed, 1.1 m/s. Core body temperature, measured using implanted thermistors, decreased as much as 4° C at the onset of diving. At sea oxygen consumption of seals spending 89% of the time submerged was only 0.8 - 1.3 times the rate measured during on-shore fasting. Such a low field metabolic rate for a diving vertebrate is probably due to low swimming speeds, reduced core temperature, and redistribution of blood flow. Extreme expression of these adjustments may occur during exceptionally long dives and would help to explain the perplexing dive performance of elephant seals.

OCCURRENCE OF MUD ON BOWHEAD WHALES (BALAENA MYSTICETUS) NORTH OF BARROW, ALASKA

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The majority of the bowhead whale population migrates annually past Point Barrow, Alaska, between April and June. Aerial photogrammetric surveys north and east of Point Barrow have documented the occurrence of mud adhered to the dorsal and lateral surfaces of many bowhead whales. In 1989, most muddied individuals had traces of mud on their rostrums or lower jaws, while in 1990, mud often covered the entire heads of animals. Our analysis included only photographs of whales that were visible from rostrum tip to fluke notch. In 1989, mud occurred on 22% of the bowhead whales and occurred on 56% in 1990. There was a significant difference ($p \cong 0.03$) in the number of muddied bowhead whales between 1989 and 1990. Mud occurred on both juvenile and adult bowhead whales in both years, and there was no difference between the proportions of muddied animals in the size classes and the proportions of the size classes in the population within years ($p > 0.50$). The spatial distribution of animals with and without mud on their bodies in 1989 was different from the distribution in 1990. In 1989, 69% of the locations of sightings of muddied and 60% of the locations of non-muddied whales occurred at depths between 30 m and 100 m. In 1990, 86% of muddied bowhead whales and 70% of non-muddied bowhead whales were sighted at locations where the water depths were between 18 m and 30 m. Epibenthic feeding, accidental contact with the ocean floor, and intentional rubbing are possible explanations for the observed phenomenon. Differences in the distribution and abundance of individuals occurring with and without mud on their bodies between years may be related to some combination of ice conditions and the local availability of invertebrate prey species.

SPERM WHALES BEHAVIOR OFF THE CANARY ISLANDS

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Sperm whales (*Physeter macrocephalus*) groups are found a few nautical miles off the Canarian coasts, where the maritime traffic between the islands is intense. The knowledge of sperm whales movements in this area is of primary importance for the commercial companies to avoid accidental collisions.

The aim of this study (started in October 1992 and due in September 1994) is to provide informations on the behavior, group composition and seasonal distribution of sperm whales in this particular part of the North Atlantic. The possible relation between whales presence and sea-surface temperature is also under study.

Female sperm whales groups have been followed between the main islands, by using acoustic techniques involving towed hydrophones and a directional hydrophone mounted aboard a relatively small research vessel.

The preliminary results indicate that sperm whales groups were first detected in the area of interest at the end of January 1993.

The first trackings underline a regular movement of the groups between the islands, following the exact contour of the coast, with no obvious relation with the variation of the grounds depths.

The satellite images of the sea-surface temperature so far analysed confirm the possibility of the presence of sperm whales groups on the edge of cold water fronts.

RECENT TRENDS IN RELATIVE ABUNDANCE OF DOLPHINS IN THE EASTERN TROPICAL PACIFIC

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Methods for estimating relative abundance of seven dolphins stocks in the eastern Pacific Ocean, using sightings data collected on commercial tuna vessels by trained observers, were developed in order to monitor the effects of the mortality incidental to the tuna purse-seine fishery. These methods are used to analyze recent trends in the abundance of the populations. For most dolphin stocks, there is no evidence of significant trends in population size, suggesting that the stocks are stable. The exception is the northern stock of the common dolphin, which shows a significant decrease in the eastern tropical Pacific due to a shift in spatial distribution, possibly related to changes in the oceanographic conditions.

HABITAT UTILIZATION BY THE SEA OTTER (*ENHYDRA LUTRIS*) IN PORT VALDEZ, ALASKA

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Sea otters are a comparatively recent addition to the marine ecosystem in Port Valdez, Alaska. The first major sighting there occurred in 1984, with 76 otters. The high metabolic rate of sea otters, coupled with their sensitivity to oil contamination, makes these top predators a particularly useful indicator of the effect of industrial development in this Alaskan fjord. As the marine terminal for the Trans Alaska Pipeline System, a favored location for sport and commercial fisheries, and a major deployment port for tourism, Port Valdez is unique among the northern fjordic environments in its high potential for human impact on the Prince William Sound sea otter population.

The impact of human activity on the sea otter's habitat in Port Valdez was assessed by examining their spatial and temporal dynamics, numbers, behavior, energetics, and responses to disturbance in the vicinity of the Alyeska Pipeline Service Company marine terminal compared with that in Shoup Bay, an area of low human activity. This study was conducted from September 1989 to September 1991. Through surface and aerial censuses, the numbers of sea otters in the fjord were found to vary seasonally. These animals also show site specificity in their activities. Port Valdez is primarily a juvenile male area, but sightings of adult males and females with pups are not unusual. Visual sampling of behavior was conducted to construct an activity-time budget for sea otters in the two study areas. Sea otter energetics were examined in terms of diet composition and caloric value. *Mytilus edulis*, the primary prey species in Port Valdez, showed significant variation in caloric content among size classes. Petroleum hydrocarbon concentrations in the primary prey and boat traffic quantification were used to measure human disturbance in the study area. The Alyeska marine terminal had the higher levels of disturbance and potential disturbance, but the concentrations of aromatic and alkane hydrocarbons were at trace levels in both study areas. Sea otters are ecologically plastic organisms. They appear to have adapted to Port Valdez to the extent that this industrial fjord can support them.

INTER-ISLAND VARIATION IN THE DIET OF FEMALE NORTHERN FUR SEALS (CALLORHINUS URSINUS) IN THE BERING SEA

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Studies of northern fur seal (Callorhinus ursinus) diet have been conducted throughout their range. Yet, none have examined diet as it relates to differences in the physical and biological environment surrounding breeding locations. Fecal material from female northern fur seals was analyzed to compare diet during the 1990 summer breeding season at St. Paul, St. George and Medny Islands in the Bering Sea, to compare diet between St. Paul and St. George Islands in 1988, and to examine inter-annual variation on St. Paul Island from 1987-1990. Dietary composition among seals from each island varied with island location relative to the continental shelf break and frontal zone structure. St. Paul animals with the greatest distance to the shelf break and broadest frontal zone structure consumed mostly (53% occurrence) juvenile walleye pollock (Theragra chalcogramma), Medny animals with the least distance to the break and most compressed frontal zone structure ate mostly (67% occurrence) squid (Gonatopsis borealis/Berryteuthis magister), and St. George animals with an intermediate location preyed on nearly equal portions of each prey type (23% occurrence of pollock, and 27% occurrence of squid). Primary prey types were consistent between years on St. Paul Island. However, pollock varied in frequency from 40% to 73% over the years, relative to pollock year-class success and availability. Female fur seals from each of these Bering Sea Islands relied on different prey assemblages that reflected the oceanographic environment surrounding their breeding location.

GEOGRAPHICAL VARIATION OF STRIPED DOLPHINS, *STENELLA COERULEOALBA* FROM SKELETAL MORPHOMETRICS AND MERISTICS

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Osteological variation between geographical populations of striped dolphins, *Stenella coeruleoalba*, were investigated utilizing 30 cranial and 24 post-cranial morphometric and 24 meristic measurements. Data were collected from specimens in museum collections representing populations in the western North Pacific, the eastern tropical Pacific, the western Atlantic, the eastern Atlantic, and the western Mediterranean.

Only physically mature specimens were selected for analysis. The criteria used to determine physical maturity were total body length greater than 180cm, the extent of fusion of the maxilla/premaxilla at the distal end of the rostrum, the degree of occlusion present in the cranial hiatus, and the extent of vertebral epiphyseal fusion. The criteria were used either singly or in combination with each other in separate analyses.

Much overlap exists between populations for the meristic measurements. The morphometric data were analyzed using principal components analysis (PCA) and canonical analysis. Preliminary results from the PCA indicate that striped dolphins from the western North Pacific tend to have a higher score on the first principal component than those from the eastern tropical Pacific. Because the first principal component corresponds to variation in size rather than variation in shape, these results suggest that mature animals from the western North Pacific are larger than those in the eastern tropical Pacific.

CONSERVATION AND GENETICS OF THE HAWAIIAN MONK SEAL (*MONACHUS SCHAUINSLANDI*)

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The Hawaiian monk seal (*Monachus schauinslandi*), a Hawaiian endemic, is currently considered the most endangered seal in U.S. waters. Populations of monk seals in the Northwest Hawaiian Islands range from Midway to the main Hawaiian Islands. Tagging studies conducted by the National Marine Fisheries Service indicate that Hawaiian monk seals have a low incidence of inter-atoll movement and a high fidelity to natal beaches. In other marine animals such as the green sea turtle (*Chelonia mydas*) and the humback whale (*Megaptera novaeangliae*), philopatry has been shown to be associated with genetic subdivisions between populations. This suggests the possibility that significant genetic divergence may exist between monk seal populations. Two distinct conservation strategies are possible for the management of endangered species. One strategy manages the species as a single panmictic population. Alternatively, populations within a species may be managed as distinct demographic units. It is therefore necessary to determine the extent of genetic differentiation between populations in order to make effective management decisions. DNA sequence analyses of the mitochondrial d-loop of the Hawaiian monk seal will determine inter-populational genetic differentiation. This information will allow conservation mangers to determine the best conservation management strategy for these endangered seals.

OFFSPRING SEX RATIO IN RELATION TO FEMALE SIZE IN SOUTHERN ELEPHANT SEALS

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In species for which reproductive success of offspring is related to their size and/or condition and where this differs between the sexes, theory predicts that the sex ratio of offspring should vary with the condition of the mother. This has rarely been demonstrated. Southern elephant seals (Mirounga leonina) should present an unequalled test of this hypothesis; they are the most polygynous of seals, only the heaviest 2-3% of males have access to females for breeding and there is a threefold difference in mass of breeding females (range 296-977 kg, N=151). We show that for all sizes of mother, male pups are born proportionately heavier (average 14%), reflecting higher nutrient and energy input during gestation, than for female pups. The mean weight of mothers of male pups (554 kg, S.E.=14 kg) was significantly greater than that of female pups (506 kg, S.E.=13 kg; $P<0.05$, DF=149). Furthermore, females weighing less than 380 kg only produced female pups. Thereafter the proportion of male pups born increased rapidly with female mass, leveling off when 51% of pups born are males, and at a female size of about 425 kg.

Male pups are larger, for all sizes of mother, and consequently more costly both to bring to parturition and to nurse (Fedak et al. in this volume). Small females may benefit from interrupting a pregnancy when bearing a male foetus, before the cost becomes significant. In so doing a female may allocate resources to her own growth, and so give birth to a larger pup when she breeds next.

SCARRING IN HUMPBACK WHALES *(MEGAPTERA NOVAEANGLIAE)* MIGRATING OFF THE COAST OF SOUTH EAST QUEENSLAND, AUSTRALIA

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Scars of different types are common on the body dorsal surface and ventral fluke surface of humpback whales. Sources of scarring in humpback whales may include contact with each other, contact with man-made apparatus, contact with large vertebrates (especially killer whales), parasites (vertebrate and invertebrate) and infection (bacterial viral and fungal).

Humpback whales migrate past North Stradbroke Island on their annual migration. A +proportion of the population enters Hervey Bay on the southward journey. Scars and deformities were examined on the dorsal body and ventral fluke surfaces of 108 humpback whales photographed off North Stradbroke Island in 1992 and 144 humpback whales photographed in Hervey Bay in 1988. Each animal was ranked on a scale of 0 to 5 in increasing order of scarring. There was a significant difference in scarring between the two locations. In the sample from North Stradbroke Island 38.9% of the whales showed evidence of contact with killer whales compared with 27.1% for the whales from Hervey Bay. Deformities of the flukes or dorsal fin were found in 17.6% of the whales off North Stradbroke Island and in 9.7% of the whales from Hervey Bay. The data suggest that the whales in Hervey Bay may represent a sub-section of the migrating population found off the east Australian coast. Skin biopsies were obtained for 64 of the photographed animals in order to investigate the relationship between sex and degree of scarring.

The incidence of rake marks caused by killer whales is higher than reported in the northern hemisphere. The results suggest that there may be a higher level of interaction between the two species in the southern hemisphere.

TEMPORAL PATTERNS OF MILK PRODUCTION IN ANTARCTIC FUR SEALS (ARCTOCEPHALUS GAZELLA)

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In Antarctic fur seals, normal variation in foraging trip duration has no effect on pup growth. Therefore, although milk transfer to pups at each attendance period may vary between mothers, the absolute amount of milk delivered during the whole of lactation is the same. Mothers (n=16) were captured, as they reunited with their pup after a foraging trip, to investigate the temporal patterns of milk production. Each one was milked by manual expression with the aid of oxytocin (2-5 IU, IM) until the mammary was completely empty. Mothers and pups were then kept in adjacent enclosures. Mothers were re-milked after 16-24 h. Milk volume carried ashore was unrelated to foraging trip duration ($P>0.2$) but was positively correlated with maternal mass ($r^2=0.21$, $P<0.04$). At least 7 (44%) mothers returned ashore with mammary glands only partially filled (<50% full in some cases). Rate of milk production at sea was negatively related to foraging trip duration ($r^2=0.4$, $P<0.01$). In contrast, rate of milk production while ashore was positively correlated with foraging trip duration ($r^2=0.51$, $P<0.01$) and maternal mass ($r^2=0.33$, $P=0.038$). Estimates of absolute milk volume delivered to pups at each attendance period were positively correlated with foraging trip duration ($r^2=0.57$, $P<0.01$). Antarctic fur seal mothers appear to vary the rate of milk production according to whether they are at sea or ashore and in relation to their foraging time budgets.

THE ESTROUS CYCLE OF THE HAWAIIAN MONK SEAL AND ITS RELATION TO MALE SEAL AGGRESSION

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The estrous cycle of the only captive adult female Hawaiian monk seal (Monachus schauinslandi) was characterized using progesterone and estrone sulfate concentrations in the plasma and saliva. The estrous cycle was 35±3 days in duration and, in contrast to other phocids, the seal was poly-estrous. Both hormones were well correlated between the plasma and the saliva, providing a less invasive means of monitoring reproduction. The estrous cycle was used to estimate the reproductive status of female monk seals fatally injured by male seals in the wild. By assessing the reproductive status at death, we estimated the status at the time of injury for 9 seals. All seals were in a follicular phase when they were first injured, with 7 of the 9 seals injured at least once during the estimated period of estrus. We conclude that most female monk seals that die following an attack by male seals are periovulatory. We postulate that olfactory cues of a pheromonal nature may communicate the reproductive status of a female seal.

ECHOLOCATION SIGNALS AND TRANSMISSION BEAM PATTERN OF A FALSE KILLER WHALE (*PSEUDORCA CRASSIDENS*)

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The echolocation transmission beam pattern of a false killer whale (*Pseudorca crassidens*) was measured in the vertical and horizontal planes. A vertical array of seven broadband miniature hydrophones was used to measure the beam pattern in the vertical plane and a horizontal array of the same hydrophones was used in the horizontal plane. The measurements were performed in the open waters of Kaneohe Bay, Oahu, Hawaii, with the whale performing a target discrimination task. The width of the beams in both planes were similar to those of the Atlantic bottlenose dolphin (*Tursiops truncatus*), and broader than those of the beluga whale (*Delphinapterus leucas*). The major axis of the vertical beam was directed slightly downwards between 0 and −5°, in contrast to the +5 to 10° for *Tursiops and Delphinapterus*. The beam in the horizontal plane was directed forward. Differences in the fatty structure of the melon of *Pseudorca*, *Tursiops* and *Delphinapterus* could explain differences in the elevation angle of the vertical beam axis. The properties of the signal measured along the major axis of the beam will also be discussed.

ORGANOCHLORINE PESTICIDES, POLYCHLORINATED BIPHENYLS, AND POLYCHLORINATED TERPHENYLS IN SEA OTTERS (*Enhydra lutris*) FROM CALIFORNIA, SOUTHEAST ALASKA, AND THE ALEUTIAN ISLANDS

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This study was initiated to determine if environmental pollutants could be contributing to the depressed rate of increase in the California sea otter (*Enhydra lutris*) population: 5-7% compared with 17-20% in more northern populations including Alaska. Organochlorine pesticides, polychlorinated biphenyls (PCBs), and polychlorinated terphenyls (PCTs) were measured in liver and muscle tissue of sea otters from California, Southeast Alaska, and the Aleutian Islands during 1992/1993. The geometric means for ΣDDTs in liver samples were 980 ug/wet kg for California, 270 ug/wet kg for the Aleutian Islands, and 5.0 ug/wet kg for Southeast Alaska. Geometric means for ΣPCBs were 420 ug/wet kg for the Aleutian Islands, 340 ug/wet kg for California, and 20 ug/wet kg for Southeast Alaskan otters. ΣDDTs/ΣPCBs ranged from 2.9 in California, 0.6 in the Aleutians, and 0.2 in southeast Alaskan otters. Organochlorine (OC) levels were consistently lower (2.5-5x) in muscle than in liver within each site, however no muscle tissue was analyzed from Aleutian Island sea otters.

Polychlorinated terphenyls (PCT) were detected only in sea otters from the Aleutian Islands. PCB and PCT profiles from the Aleutians are similar to those found in sediments from San Diego Harbor and Winter Quarters Bay, Antarctica; all sites of substantial ship traffic.

BODY COMPOSITION CHANGES IN FASTING POLAR BEARS (*URSUS MARITIMUS*): THE EFFECT OF FATNESS ON PROTEIN CONSERVATION.

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Studies suggest that characteristically obese species such as ursids and pinnipeds, can efficiently spare protein during prolonged annual fasts. The present study was conducted to investigate body composition changes in fasting adult female polar bears and their cubs during the annual summer-fall ice-free period, in the Churchill region of Manitoba, Canada. A total of 14 adult females and 20 cubs were handled in either 1989 or 1992. Body composition was determined, by isotopic dilution or bioelectrical impedance analysis (BIA), once at initial capture and then again 3-4 weeks later.

There was considerable variation among animals in calculated body composition changes. For adult females, estimated rates of fat loss (kg/day) were unrelated to lean body mass (LBM) at initial capture (r^2=0.05, p=0.44), but positively related (r^2=0.37, p=0.02) to an index of fatness (fat:LBM [kg/kg]). As fat is the primary constituent of milk, this result likely reflects the sensitivity of lactational expenditure to body condition. In contrast, rates of lean tissue loss were positively related to LBM at initial capture in both adult females (r^2=0.52, p<0.01) and yearling cubs (r^2=0.78, p<0.001). Overall, the percentage contribution of fat to estimated changes in total body-gross energy (TBGE) ranged from 56% to 100% in adult females and yearlings, and was positively related to fatness (r^2=0.45, p<0.01).

We conclude that polar bears possess significant protein reserves which may be accumulated annually during periods of hyperphagia. The relative importance of these reserves in meeting the energy requirements of fasting is dependent upon body fatness. Furthermore, the use of protein reserves is regulated with respect to body-size specific set-points for minimum total protein. Catabolism of excess lean tissue may be an adaptive strategy for reducing metabolic requirements during periods of fasting and restricted activity.

DWARF SPERM WHALES STRANDINGS AND SIGHTINGS ON THE SOUTHWEST COAST OF THE GULF OF CALIFORNIA, MEXICO.

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Seven strandings and three sightings of dwarf sperm whale, *Kogia simus*, have been taked on the southwest coast of the Gulf of California from 1983 to 1993.

All the strandings occurred in the Bahía de La Paz, B.C.S.: 1) a 2.12 m male on February 1993; 2) a 1.85 m unknown gender on August 1983; 3) a 2.27 m female with a .59 m fetus on October 1983; 4) a 2.28 m female with a .73 m fetus on March 1985; 5) two animals but only a 2.16 m unknown gender was recovered, on September 1989; 6) a 2.20 m female on November 1990; and 7) a 1.93 m female on July 1993.

The three sightings were: three individuals off Punta Gorda on February 1993; a single individual between Loreto and Isla del Carmen on June 1993; and a single individual in the Bahía de La Paz on July 1993.

The records cover from February through November that suggests dwarf sperm whales are local year-round residents.

Local fishermen reported that a common cetacean called "vaquita" was frequently seen producing a red cloud of feces ("startle response") when the animals were disturbed while basking. This behavior was informed for the pygmy sperm whale, *Kogia breviceps*. Due the larger frequency of *Kogia simus*, in contrast to only one stranding in the area of pygmy sperm whale, and the more coastal distribution of the dwarf sperm whale, we can assume this behavior applies also for this species.

LONG-TERM MONITORING OF FIXED HYDROPHONE ARRAYS IN THE TEMPERATE NORTH PACIFIC: RESULTS OF YEAR ONE.

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The distriubtion of large marine mammals can be determined by localizing their low-frequency phonations using permanently deployed hydrophones. This study monitored hydrophones at five sites around the temperate North Pacific for one year for signals under 50 Hz. Signals likely to be of biological origin were categorized, and patterns of geographic, seasonal, and diurnal variation were analyzed. Source locations were calculated for selected signals that were received at a sufficient number of sites. Over 400,000 signals likely to be of biological origin were received in the first year. Geographic, seasonal, and diurnal variation in signal rates were found. Since most signal categories did not match well with previously reported species-specific phonations, ground-truthing will be required to verify the identities of species producing the sounds. The results of this preliminary study suggest that hydrophone arrays provide a powerful tool for studying: 1) the distribution of large whales, and in turn the spatial and temporal scales of movements of the large vertebrate component of marine communities; 2) oceanographic features which correlate with whale distribution; and 3) acoustic behavior of whales, and how it might be affected by high levels of low frequency noise or other disturbances.

AN EXAMINATION OF KILLER WHALE DIVING BEHAVIOUR USING A RECOVERABLE, SUCTION-CUP ATTACHED TDR/VHF TAG

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A recoverable time-depth recorder/VHF radio tag with suction attachment was developed and tested on killer whales off southern Vancouver Island, B.C. A galvanic/magnesium system was incorporated to release suction of the suction cup so the tag would detach from a whale after a pre-set period, then float for recovery. These tags were attached to resident- and transient-form killer whales from a small (4.7 m) vessel, using a 3-4 m pole and a crossbow. The tag used in the first successful tracking in 1991 lacked the internal electronics of the TDR unit, as it was designed to test the effectiveness of the recoverability of the tag and suction attachment method. Several successful trackings in June and July 1993 of resident killer whales provided up to 8 1/3 h of continuous dive depth recording. Concurrent with radio tracking whales was recording of LORAN-based positions, whale behaviour, and associations with other whales. In the 8 1/3 h tracking a total of 737 consecutive dive profiles (samples taken 1/sec) were logged, with 162 m being the maximum depth recorded. On 12 occasions the whale dove to the sea-bottom when depths were 100 m or more. Maximum short-term velocity during descents and ascents reached 6 m/sec.

SEMEN COLLECTION, TESTOSTERONE LEVELS AND REPRODUCTIVE MATURITY IN MALE SEA OTTERS

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This study was conducted to evaluate the feasibility of semen collection and estimate age at reproductive maturity in male sea otters (*Enhydra lutris*). Twenty-two male sea otters weighing >23 kg were captured in Prince William Sound, AK, sedated and subjected to electroejaculation for collection of semen samples. Blood was also collected and levels of serum testosterone were measured. Ages of the sea otters, estimated by counts of cementum annuli on extracted premolars, ranged from 2 to 16 years. Semen samples with detectable concentrations of sperm were obtained from 18 of the 22 sea otters. No sperm were obtained from the only sea otter estimated to be 2 years of age, but sperm were obtained from 4 of the 5 (80%) sea otters estimated to be 3 years of age, and from 14 of the 16 (87.5%) sea otters estimated to be 4 years of age or older. Ejaculate volumes were small (generally less than .5 ml), and concentrations of sperm cells were relatively low, ranging from 10^4 to 10^8 cells/ml. Testosterone levels ranged from 69 to 7546 pg/ml, and were positively correlated with sperm concentrations. Microscopic examination of samples from 7 otters showed high levels (57% to >90%) of morphological abnormalities of the sperm cells. The data demonstrate that semen production is ongoing in male sea otters by 3 years of age, and that electroejaculation can be used to collect sea otter sperm samples.

JUVENILE HUMPBACK WHALES RETURNING TO THE NEARSHORE WATERS OF VIRGINIA

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Humpback whales (*Megaptera novaeangliae*) in the western North Atlantic use summer feeding grounds in the higher latitudes off the United States and Canada and winter breeding grounds in the Caribbean. Since 1991, though, small numbers of juvenile whales have been observed feeding in the winter in the nearshore waters off Virginia. After two years of photo-identification work, 18 individual whales have been identified. Based on photographic resights of individually identifiable whales, 5 of the 12 whales that we identified in the winter of 1992 returned to the same area in 1993. In 1993, the 5 returning whales stayed significantly (Mann-Whitney p=0.01) longer than 6 newly identified individuals. The juvenile humpbacks concentrate in the study area off the coast of Virginia Beach, Virginia from early to mid-January until late February or early March exhibiting behaviors consistent with feeding. The photographic resights in 1993 indicate that juvenile humpback whales exhibit a degree of site fidelity to the winter feeding area off Virginia.

MASS CHANGE IN FASTING IMMATURE MALE NORTHERN FUR SEALS

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Rate and magnitude of mass change in fasting immature male northern fur seals (*Callorhinus ursinus*) were estimated. A total of 271 2- through 5-year-old males (tagged as pups) were weighed at least twice within fasting bouts during the 1990-1992 breeding seasons on St. Paul Island, Alaska. Average initial mass was 33.6 kg (range 19.0-60.7 kg). During fasting, absolute rates of mass change (averaging -0.68 $kg \cdot day^{-1}$) were positively correlated with initial mass ($p < 0.001$). Mass-specific rate of change (averaging $2\% \cdot day^{-1}$) did not vary with age or initial mass. The maximum loss observed was nearly 30% of initial body mass; the estimated average mass loss per shore visit was 20%. This is somewhat less than mass loss reported for territorial adult male pinnipeds. Although they lost large amounts of mass while fasting, immature male fur seals achieved a significant net increase in mass by making feeding trips to sea ($p < 0.01$). The capability for prolonged fasting in immature males facilitates development of social and sexual skills which are likely to increase future reproductive success.

A COMPARISON OF THE ACOUSTIC REPERTOIRES OF THE HARP (PHOCA GROENLANDICA), HOODED (CYSTOPHORA CRISTATA) HARBOUR (PHOCA VITULINA) AND GREY (HALICHOERUS GRYPUS) SEALS

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The acoustic repertoires of 4 species of North Atlantic phocid seals were compared in order to determine the impact of social structure and physical environment on their respective communication systems. Comparisons included the total number of different signals in the repertoire, the frequency with which each species vocalizes, structural characteristics of calls and the behavioural contexts of signals. Interspecific comparisons were made between those calls that appeared to be structurally similar and that appeared to be emitted in similar behavioural contexts. Grey seals seem to require a larger number of airborne calls to maintain social order on their breeding grounds than do harp, hooded and harbour seals. Under water, harp seals appear to have undergone an ecological release, allowing the development of a complex repertoire. The repertoire of harbour seals is probably constrained by environmental noise and predation pressure. Finally, hooded seals are primarily a solitary species and probably do not require as many different types of signals, emitted in as high a frequency as do harp and grey seals to maintain their social system. Therefore, several factors, including mating systems, degree of sociality and environmental features contribute to the degree to which individual species use acoustic communication.

IMPLICATIONS FOR PHOCOENID EVOLUTION AND PHYLETIC RELATIONSHIPS AS SUGGESTED BY THE PRIMITIVE LATE MIOCENE FOSSIL PORPOISE, *Piscolithax tedfordi*, FROM ISLA DE CEDROS, MEXICO

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The odontocete family Phocoenidae, comprised of the living harbor porpoises and other related living and extinct species, has a fossil record going back to approximately 11 Ma. The family is classified in the superfamily Delphinoidea with the extant families Delphinidae and Monodontidae, and the extinct Kentriodontidae and Albireonidae. Several rare fossil phocoenids are known, but the delphinoid group from which phocoenids arose is unknown, and osteological characters useful in evaluating the evolutionary relationships of the fossil and living species have not been firmly established. Convergence with *Cephalorynchus* (delphinid) and severe paedomorphism mask relationships of extant species.

The most primitive known fossil phocoenid, *Piscolithax tedfordi* Barnes, 1984, from the latest Miocene (*circa* 8 Ma) part of the Almejas Formation on Isla de Cedros, off the west coast of Baja California, México, sheds light on the origin and early evolution of the family. In life this fossil porpoise was approximately 2.5 m long and its body shape might have somewhat resembled that of the living bottlenose dolphin, *Tursiops truncatus*. *Piscolithax tedfordi* had a robust skull with large crests and processes, a deep brain case, and a long rostrum of moderate width, numerous large teeth, unfused cervical vertebrae, elongate vertebral centra, and a long and broad pectoral flipper with anteroposteriorly expanded radius and ulna.

Cladistic analysis suggests that Phocoenidae may be a sister taxon of Delphinidae. Cervical vertebra fusion, sometimes thought to be a shared derived feature between Delphinidae and Phocoenidae, developed convergently, and is not indicative of phylogenetic relationships. There were several lineages of phocoenids after Late Miocene time, but most did not survive to the present. Whereas the fossil record shows that the earliest phocoenids appear to have been large, off-shore, deep water species, most later species lived closer to shore in shallow waters, were smaller, and became progressively more paedomorphic.

FREQUENCY OF FISHERY INTERACTIONS AMONG LIVE STRANDED PINNIPEDS IN CENTRAL AND NORTHERN CALIFORNIA

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The Marine Mammal Center (TMMC) has responded to live strandings of marine mammals along the central and northern California coast since 1975. Six pinniped species are recovered in this range, Zalophus californianus, Mirounga angustirostris, Phoca vitulina, Callorhinus ursinus, Eumetopias jubatus and Arctocephalus townsendi. Five of these 6 species have stranded with problems associated with fishery interactions (the exception is Callorhinus). Fishery interactions were categorized as follows: gill net, gunshot, fishing tackle injuries, and a fourth category of debris, which included either ingestion or entanglement. From 1986 to 1992, 169 live, stranded pinnipeds were recovered by The Center with fishery interactions. Of these, 116 had gun shot injuries, 33 had gill net injuries, 13 had fishing tackle injuries and 2 had debris injuries. One hundred and fifty-five Zalophus, 5 Mirounga, 5 Phoca, 3 Arctocephalus and 1 Eumetopias were recovered. The majority of these strandings (n=98) were during the El Niño oceanographic conditions of 1992, although strandings occurred in every year.

SIGHTING CHARACTERISTICS AND GROUP SIZE IN Pontoporia blainvillei (Gervais & D'Orbigny,1844)

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Biological studies on the Platanistoid dolphin Pontoporia blainvillei, or Franciscana, began during the seventies. Most of the information derived from specimens taken incidentally in coastal gill-net fisheries and also from a small number of stranded specimens.

As this small dolphin is very difficult to see in the wild and sightings are very scarse, it was erroneously considered as a species of solitary habits.

Through a coastal sighting project developed in the Mar del Plata's area (Argentina) since 1976, and recently expanded to Bahía Samborombón, it was possible to state that this dolphin is not a species of solitary habits. It can form groups of variable number of specimens, up to a maximum of forty individuals. The general movements of P.blainvillei in the studied area are mainly related with reproductive activities and general cycles of its prey species.

These new records from the wild open new perspectives for abundance estimates, in order to evaluate the impact of incidental catch in this dolphin populations. The possibility of a line-transect method for population estimates in this species should not be discarded.

From a regional point of view, it has to be defined if the sighting possibility of this species also exists in other areas of its geographical distribution.

'RHYTHM BASED TIME'

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Humans principally encode information in Signals. Animals do also but to a far more limited degree. Research with humpback, minke, fin and pilot whales during the last 25 years demonstrates that these species and possibly all animals, additionally encode information in Time. In this novel model messages become independent from signals and so also does Space become independent from Time. The experimental discovery of 'Message Time-Compression' in 1991 and 1992 defines a whale used Biological Time that can compress by a factor of at least 120. This result mathematically defines a new form of Time that can and does travel faster than the speed of light. A communication system is thus explained where information from whale to whale or from whale to human can travel virtually instantaneously, easily understood by the fundamentals of 'Rhythm Based Communication', that is 'Synchronization' and the continuous resetting of mental clocks which represent the 'Alpha' rhythms of other animals. It has become emphatically clear that this is a new form of Time called 'Rhythm Based Time' and that it may represent the pathways for vast networks of both animal and human communication. Results and conclusions are described in a new book entitled 'Dancing with Whales' ISBN 1-895387-28-0.

DISTINGUISHING PARAPATRIC POPULATIONS OF EAST FLORIDA BOTTLENOSE DOLPHINS USING FOOD HABITS DATA

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Localized populations of coastal and offshore bottlenose dolphins exist along the U.S. Atlantic coast. Whereas the coastal and the offshore ecotypes can be easily separated, distinguishing among populations of the coastal ecotype is difficult. In this study we used food habits data (1977-1992) to distinguish between parapatric populations of dolphins in the east coast of Florida: a resident, estuarine population and dolphins occurring in adjacent oceanic beaches. Resident dolphins (n= 38) are primarily piscivores whereas oceanic dolphins (n= 39) feed on fish and squid. Although there is overlap in their diets, key prey species occur in each particular habitat. Resident dolphins favor non-schooling, seagrass-associated species (e.g, toadfish, pinfish) and oceanic dolphins prey more heavily on schooling species associated with unvegetated, high-energy habitats (e.g, anchovies, jacks). These differences are probably related to the different foraging strategies employed, resident dolphins generally feeding solo and oceanic dolphins congregating into larger schools to feed.

UNDERWATER VIDEO RECORDING OF HUMPBACK WHALE BEHAVIOR

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Five hours of video recording in Hawaii over a period of 3 months during the winter of 1993 provided detailed observations of the underwater activities of humpback whales. These recordings included observations of a male with an extruded penis, ventral-ventral posture, rostrum-rostrum and rostrum-genital behaviors between adults, quiescent interludes among surface antagonistic individuals, moving and stationary singers, various mother-calf interactions, and a young whale entangled by a rope. Use of Hi-8, high resolution, video tape allowed us to obtain accurate fluke identifications to complement surface photographs. It also allowed direct determination of gender from lateral and ventral images of the genital area. Underwater videography greatly increases our access to the humpback whale environment and can substantially enhance our understanding of humpback whale social behavior.

SOCIAL ECOLOGY AND BEHAVIOR OF BOTTLENOSE DOLPHINS IN THE WATERS ADJACENT TO THE ISLAND OF LOSINJ (CROATIA)

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A community of bottlenose dolphins living in the coastal waters of the Northeastern Adriatic Sea was monitored from 1987 to 1993 aboard small inflatable craft, to study the dolphins' degree of residency, abundance, and activity and association patterns. Methods included photoidentification and behavioral observations. Based on permanent natural marks, over 130 individuals were identified. A large percentage of the identified dolphins was consistently resighted during the course of the study, indicating a high level of residency for these individuals in the area. Group size (mean=5.6, se=0.19) varied widely in relation to environmental and behavioral factors, such as time of day, time of year, and type of activity. Although group size and composition appeared to be rather fluid, cluster analysis performed on coefficients of association among the most frequently sighted individuals indicated the existence of regular association patterns. All newborn individuals were observed during summer, clearly suggesting the existence of a calving season. The behavioral budget reflected a predominance of feeding-related activities over travelling and socializing, although this pattern differed significantly among seasons and among years.

NORTHERN ELEPHANT SEAL SKIN DISEASE: AN INVESTIGATION OF A POSSIBLE TOXICOLOGICAL ETIOLOGY

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The Marine Mammal Center has treated over 200 northern elephant seals (*Mirounga angustirostris*) with a disorder known as northern elephant seal skin disease (NESSD). The cause of NESSD is unknown but death can result from sepsis. The ulcerative, hyperkeratotic lesions and increased susceptibility to infectious agents are known responses to retinol deficiencies in mammals. Depressions in serum retinol (vitamin A) and thyroxine (T4) can also indicate exposure to halogenated aryl hydrocarbons like PCBs. This study was designed to assess if an association between NESSD and PCB exposure exists.

This study characterized the serum biochemical alterations associated with NESSD and assessed organochlorine (OC) compound levels in blubber and serum in 10 diseased yearling seals at TMMC compared with 15 non-diseased wild seals during the 1992 moult. Body composition was determined by multiple girth/length measurements and ultrasound of blubber layers.

Diseased seals have depressed levels of T4, T3, retinol, serum iron and cholesterol while they have elevated levels of SGOT, LDH, and uric acid compared to controls ($P \leq 0.005$). Body composition analysis for both groups showed approximately 35% adipose and 65% lean tissue. However, morphometric measurements showed that diseased animals are significantly smaller in absolute size than their non-diseased cohorts as indicated by a 15% decrease in cranial girths.

Significant differences were seen in the sera concentrations of OCs between groups. Therefore, it would seem that NESSD and PCBs are associated symptomatically if not causally but further investigation will be needed.

MATING BEHAVIOR OF THE FRESH WATER DOLPHIN Inia geoffrensis (DE BLAINVILLE, 1817) IN AN ORINOCO TRIBUTARY OF COLOMBIA

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42 strip transects were carried out along the Arauca river and some of its tributaries (Colombia Orinoquia) in order to estimate the population of Inia geoffrensis. Photoidentification was used to identify individuals; behavior was registered by taking serial record of focal groups. The water level was low and the dolphins were concentred in very few places.

27 animals were observed in the area, with a density of 1.21 individuals per kilometre. 13 individuals (48% of the total) were identify by notches, pigmentation patterns and malformations. Dolphins were observed for 40 hours. Adult dolphins devoted 60% of this time to reproductive activities, and the remainder to feeding, travelling and social activities. Juveniles and calves invested their time in diferent ways: juveniles spent 40% of their time interacting with the adult mating group, and 60% feeding and socialising with other juveniles. Calves devoted 70% of their time to fishing, sometimes in groups, sometimes on their own.

Mating adults increased their underwater activity and twin wakes could often be seen on the surface. The mating proces began with the male repeatedly showing its dorsal fin above the surface and occasionally tail slapping the water, while approaching the female. The male then swan side by side with the female and the two animals rolled over, with genital contact. This sequence was repeated several times until the female swam rapidly away. At first the male tried to pursue the female but, then returned to the group to mate with another female. The whole mating proces was seen on many occasions, suggesting that further observations are needed to establish whether Inia geoffrensis is monogamous, as has been proposed in previous studies.

STATUS OF HARBOUR PORPOISES (Phocoena phocoena) IN SWEDISH WATERS.

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Bones of harbour porpoises found in human settlements dating back 5000 years on the island Gotland show that harbour porpoises were hunted in the Baltic Sea during this time. The hunt continued into modern times but came to an end in the beginning of the 20'th century. Although, there are no abundance estimates for this area, few sightings or incidental takes have been reported indicating that very few harbour porpoises remain in the Swedish Baltic Sea.

The situation on the west coast of Sweden, in the Kattegat and Skagerrak Seas, is different. In this area 480 carcasses were collected by the Swedish Natural History Museums during June 1988 to December 1991; 60% of these were incidental takes in commercial fisheries. The incidental takes, on average 80 animals per year, should be looked upon as minimum numbers since they were obtained through a voloountary reporting system. Aerial surveys performed in the Kattegat and Skagerrak Seas during 1991 reported low densitys of harbour porpoises.

Morphometric studies show that harbour porpoises in the Swedish Baltic and Skagerrak Seas should be treated and managed as a separate stocks. Harbour porpoises in Swedish waters should be considered as endangered in the Baltic Sea and threatened in the Kattegat and Skagerrak Seas. Unfortunately, the Swedish goverment has now decided to only collect animals incidentally taken or found stranded in the Baltic Sea making future assessments of the status of harbour porpoises in the Kattegat and Skagerrak Seas difficult.

REPRODUCTIVE BEHAVIOUR OF GREY SEALS (HALICHOERUS GRYPUS) BREEDING ON THE PACK ICE IN THE GULF OF ST. LAWRENCE

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Reproductive behaviour of grey seals (Halichoerus grypus) breeding on the seasonal pack ice was studied in the Gulf of St. Lawrence during January and February 1992 and 1993. Males were captured in order to obtain mass records and behaviour was quantified using scan sampling. Average male mass at first capture was 256 kg (range=176-352 kg), but decreased as the season progressed. Time-activity budget was similar to land breeding colonies. For males, differences in behaviour were related to the males' status and to the strategy used to attend females. In cases where access to water was limited to breathing holes, males attended either from the water or from the ice. In such conditions, the most successful males attended females from the water, defending a breathing hole. Reproductive success was partly dependent on the number of days spent at the patch and on male fighting ability. Ice stability and ice topography varied extremely between locations. At one site, ice was stable through most of breeding season. Females were gregarious and usually congregated around breathing holes. At that site, females were always present in greater numbers than reproductively active males. This suggested that, when ice is stable, the degree of polygyny on the pack ice is comparable to land breeding colonies.

INVESTIGATIONS ON THE ABUNDANCE, HEALTH STATUS, AND MIGRATION OF THE SMALL CETACEAN POPULATIONS IN GERMAN WATERS

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The number of small cetaceans in German water, particularly harbour porpoises, has drastically declined in the past few decades. Insufficient knowledge exists regarding the number, distribution and migratory behaviour of these populations. Even less knowledge exists about the reasons for their decline. This project is a part of an international initiative to fill the gaps in our knowledge.

Sightings: All incidental sightings in German waters were gathered and processed at the Forschungs- und Technologiezentrum Westküste (FTZ), University of Kiel. In addition to the incidental sightings, aerial surveys were conducted in certain regions during 1991 and 1992. These surveys were made possible with the cooperation of Danish colleagues.

Strandings: All strandings on the German coasts were centrally registered in FTZ. The harbour porpoises comprised the majority of the strandings (1990: 76/81; 1991: 101/104; 1992: 87/90). Strandings of white-beaked dolphins, white-sided dolphins, bottlenose dolphins and common dolph. were comparatively rare.

By-catch: Fishers from Schleswig-Holstein were responsible for most of the harbour porpoise bycatch in German waters (1990: 21; 1991: 29; 1992: 8). The fishers received 50 DM for the delivery of the animals.

Postmortem and sample taking: The strandings and by-catch from Schleswig-Holstein were examined under the zoological as well as the veterinarian perspective. Further examinations in realms of histopathology, parasitology, virology and bacteriology were coordinated from the Institut für Veterinär-Pathologie, University of Giessen. Samples were also taken for further studies in the topics of age determination, nutrition, reproductive biology and toxology.

THE EVOLUTION OF PINNIPED AQUATIC LOCOMOTOR PATTERNS

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Extant pinnipeds can be divided into three aquatic locomotor groups: forelimb swimmers (eg., otariids), hindlimb swimmers (eg., phocids) and forelimb/hindlimb swimmers (eg., Odobenus). Assumptions concerning the evolution and distribution of locomotor patterns in fossil pinnipeds can best be examined within an explicit phylogenetic context. Morphological characters correlated with locomotor structure and function were mapped onto a well corroborated phylogenetic hypothesis of pinniped monophyly. Our results indicate: 1) the ancestral pattern of pinniped aquatic locomotion was forelimb/hindlimb and 2) the pattern in all later diverging pinnipeds is forelimb/hindlimb (forelimb dominated). In otariids the forelimb pattern became emphasized. In archaic walruses (eg. Imagotaria, Gomphotaria) this forelimb pattern is retained. A forelimb/hindlimb pattern (hindlimb dominated) evolved twice, once in later diverging walruses (Alachtherium, Valenictus, and Odobenus) and again in the desmatophocid Allodesmus. The hindlimb swimming pattern in phocids represents an evolutionary novelty not seen in other pinnipeds. Further investigation of the change in locomotor pattern among walruses suggests a related change in feeding strategy.

STRUCTURE OF THE FINBACK WHALES, BALEANOPTERA PHYSALUS, OF THE GULF OF ST.LAWRENCE AND WEST GREENLAND THROUGH PHOTOIDENTIFICATION AND GENETIC ANALYSES.

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In the Gulf of St.Lawrence, an average of 900 finback whales (s.d.=422.13) are sighted every year between June and November. An yearly average of 35 individuals (s.d.=18.3) were photoidentified, where 36% were resightings. The large proportion of new individuals is probably due to sampling from a large population in an extended area.

Biopsy samples from the Gulf of St-Lawrence (n=87) and West Greenland (n=15) from 1988, 1990,1991,1992, were compared genetically. The nucleotide sequences of the first 290 basepairs at the 5'end of the mitochondrial control region (D-loop) were determined by direct sequencing of asymmetrical amplified DNA by polymerase chain reaction (PCR). The comparisons of samples from different years within the Gulf of St.Lawrence revealed no heterogeneity,thus the animals are probably from the same population.

The finback whales from the Gulf of St.Lawrence and West Greenland have been defined by the IWC as two different management areas therefore regarded as representing separate populations. The genetic analyses have showed a significant difference between the two populations, supporting the division of the areas.

HEART RATES AND ENERGETICS OF FREE-RANGING FEMALE ANTARCTIC FUR SEALS

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Monitoring the energetics of free-ranging marine mammals is notoriously difficult. To date the only means has been to use the doubly labelled water (DLW) technique which only gives an average daily metabolic rate (Costa *et al* 1989). Using this technique it is not possible to monitor the energetics over short periods of time nor is it possible to assign energetic values to different behaviours *e.g.* swimming, resting, diving. We propose that heart rate, which can now be monitored over long periods of time (Woakes, 1992), can be used to determine the energetics of these animals at sea and whilst engaged in different behaviours.

In order to estimate metabolic rate from heart rate, the relationship between the two has to be determined. This was not possible on Bird Island (where the fieldwork was performed), consequently the relationship was determined in a related species, the Californian sea lion, at the Scripps Institution, San Diego (Butler *et al* 1992). Using a swim channel built at Bird Island it was possible to determine the heart rate:metabolic rate relationship in female Antarctic fur seals over a limited number of activity levels. As the relationship between the two variables was linear in the sea-lions, a linear relationship was also assumed in the fur seal.

Heart rates and sub-cutaneous temperatures of free ranging female Antarctic fur seals (*Arctocephalus gazella*) were monitored with an implanted data-logger (Woakes, 1992) at the British Antarctic Survey base at Bird Island, South Georgia during the austral summers of 90-91, 91-92 and 92-93. A total of 26 seals were continuously monitored over periods of 3-31 days, with the monitoring periods covered nearly all of the lactation period. 15 seals also had time depth recorders (Wildlife Computers Inc.) attached to monitor diving behaviour, and 7 were dosed with DLW to compare with the estimates of metabolic rate obtained from the heart rate data.

Preliminary analysis of the data indicate that the energy expenditure of the females whilst ashore is 5.86 W.kg^{-1} and 7.03 W.kg^{-1} whilst at sea. The energy cost of the outward journey to the feeding area was 184.4 kJ.kg^{-1} whereas the return journey required 140.1 kJ.kg^{-1}. Heart rates during both journeys were not significantly different, the difference in energy requirements being due to the longer duration of the outward leg.

HIGH VARIABILITY FOR CONTROL-REGION SEQUENCES IN A MARINE MAMMAL: IMPLICATIONS FOR CONSERVATION AND MATERNAL PHYLOGENY OF STELLER SEA LIONS (EUMETOPIAS JUBATUS)

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Steller sea lions (Eumetopias jubatus) are a threatened species that have experienced a significant drop in numbers over the past three decades. Previous genetic studies indicated a lack of allozyme variability in this monotypic species. However, very high levels of variation exist in the mitochondrial DNA, as revealed by control-region sequences from 100 specimens taken over most of the range of the species. High levels of interpopulational variation were found indicating female dispersal is low. The frequencies of mtdna haplotypes were significantly different among all pairwise comparisons of the six populations (rookeries) except one. Thus, conservation and management of Steller sea lions should consider the rookery as the management unit. Patterns of macrogeographic variation indicate the presence of two relatively well differentiated populations of Steller sea lions. A western population included rookeries from the Commander Islands in Russia and the Aleutian Islands and Gulf of Alaska in Alaska. An eastern population included rookeries from Southeast Alaska and Oregon. Mitochondrial DNA appears to be potentially useful as a genetic tag to help identify the natal rookery of individuals of unknown origin.

BOTTLENOSE DOLPHINS AT TURNEFFE ATOLL, BELIZE

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A total of 194 boat-based surveys were carried out on the population of Atlantic bottlenose dolphins, (Tursiops truncatus) within the Turneffe Atoll reef, 32 km off the coast of mainland Belize. Data was collected during three separate study periods: March 1992 to April 1992, 26 surveys; July 1992 to December 1992, 96 surveys; and March 1993 to July 1993, 72 surveys. Dolphin schools were encountered on 82% of all surveys and a total of 942 dolphins were observed, including 72 calves (calf proportion = 8.4%). School size ranged from 1 to 20 dolphins and averaged 3.5 individuals. However, 78% of all schools consisted of 1 to 4 dolphins, and the median school size was 2.

The Turneffe Atoll is a diverse and highly productive tropical, coastal and marine ecosystem whose dominant vegetation consists of red, black and white mangroves, with surrounding waters including numerous coral reefs and sea grass beds. To date there have not been any studies on bottlenose dolphins in this type of environment. This project, therefore, will provide new and needed information on the behavioral ecology of dolphins in this type of habitat, and will contribute to the development of behavioral and population baselines needed to establish a proposed marine sanctuary in this still pristine area.

THE INTERNET: CHANGING THE WAY INFORMATION IS ACCESSED

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The Internet, an international network of computer networks, is revolutionizing the way information professionals, researchers, and others are accessing information. This paper will discuss information resources in the sciences available over the Internet. Through the use of the Telnet and FTP (file transfer) protocols the following types of information can now be accessed: 1) The catalogues of hundreds libraries throughout the world; 2) NSF and EPA information; 3) The Federal Register organized by subject or issuing agency; 4) data archives, including computer programs, at hundreds of sites; 5) discussion groups in the sciences; and 6) subject-oriented databases. Researchers can connect to a wide variety of science databases covering such subjects as benethic ecology, DNA sequencing, NSF programs and funding, and primatology. Directions for connecting to the resources available over the Internet either through a hard-wired networked workstation or via modem will be given. The use of the Archie and Veronica programs for finding files available via anonymous FTP and for searching and connecting to hundreds of information sources will be discussed. The Internet has forever changed the way information is accesed and transmitted. This paper will provide a basic introduction to this information resource.

FACTORS AFFECTING HARBOR PORPOISE CATCH RATES IN THE GULF OF MAINE SINK GILLNET FISHERY

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Catches of harbor porpoises (*Phocoena phocoena*) have been monitored in the Gulf of Maine sink gillnet fishery since 1989 by an onboard observer scheme. We analyzed the observer scheme data collected between 1989 and 1992 by examining porpoise catch rates in relation to 16 operational variables and in relation to fish catches by species. Catch rates appear to be independent of many of the recorded operational factors, but we found that soak duration,
depth of set, and mesh size all affected catch rates of harbor porpoises. None of these relations can be explained clearly, though we propose several hypotheses. We also examined the catch of porpoises in relation to the presence of fish species in the catch. Although there were significant correlations between the presence of porpoises and of certain fish species within a haul, these correlations were generally not consistent between years. The presence of one species, pollack (*Pollachius pollachius*), was found to be significantly correlated to the presence of porpoises within the same hauls over a two year period, which may suggest some ecological affinities.

PHOTO-IDENTIFICATION OF KILLER WHALES OFF CALIFORNIA

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Eighty-eight killer whales (*Orcinus orca*), including 33 males, were photo-identified in California waters. Number of whales identified in each area include: Cape Mendocino (2), Cordell Bank (3), Gulf of the Farallones (11), Monterey Bay (64), Morro Bay (1), Pt. Conception (4), Santa Barbara (5), Los Angeles (13), and San Diego (6). Photo-identification efforts were concentrated in Monterey Bay and off Los Angeles. Photographs were compared with images from Mexico, Washington State, British Columbia, and Alaska. Fifty-three (60%) whales were resighted from 1 to 27 times. Killer whales photographed off California were also seen in Glacier Bay, Alaska (2661 km; n=4), Tofino, British Columbia (1460 km; n=2), San Benitos Islands, Mexico (1019 km, n=7), and Los Coronados Islands, Mexico (208 km; n=1). Twenty-one whales were seen in one or more different California locations, with a maximum distance of 611 km. One male was first observed in Morro Bay, and resighted 10 times in Monterey Bay and Gulf of the Farallones over a 15 year time span. Another male was photographed in Los Angeles, resighted 25 times in Mexico, southern California and Monterey Bay over an 8 year time span. Forty-two (48%) whales, including those sighted in different areas, were associated with the same individual(s) at least twice up to 10 years after the initial sighting. The only documented prey of these whales has been 5 species of marine mammals. In conjunction with this evidence, initial insight is gained on the movements and extended ranges which possibly relates to the feeding ecology of these "transient" type of killer whales.

THE U.S. MID-ATLANTIC COASTAL MIGRATORY BOTTLENOSE DOLPHIN STOCK REVISITED

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The mid-Atlantic coastal migratory stock of bottlenose dolphins, which is thought to range seasonally from New Jersey to Florida, experienced an abnormally high level of mortality in 1987-88. Comparison between pre-1987 average annual bottlenose dolphin stranding rates and the 1987-88 stranding rate resulted in an estimate of stock reduction of about one-half after the mortality event. This stock is believed to range primarily between Cape Hatteras, North Carolina, and mid-Florida during the winter. It is unclear whether other groups, such as resident dolphins or dolphins from the offshore stock, co-occur in this region because there are little quantitative data available which describe bottlenose dolphin stock composition and boundaries in this area. Bottlenose dolphin abundance estimates from replicate aerial surveys conducted along the U.S. mid-Atlantic coast from Cape Hatteras to mid-Florida during the winter did not differ significantly between 1983 and 1992. Among potential explanations for this result is the possibility that the 1987-88 stock reduction may have been overestimated. Also, inconsistent sampling between survey periods could have confounded survey results. In addition, changes in the distribution and relative mixture of dolphin stocks between sampling periods could lead to inconclusive results. Close monitoring of this stock is warranted in light of its designation as depleted under the Marine Mammal Protection Act, but ambiguity in stock definition may contribute to both inaccuracy and imprecision in population assessment, thus rendering monitoring problematic. Studies seeking to define the coastal migratory bottlenose dolphin stock must investigate stock structure hypotheses which consider possible relationships between this stock and other population components throughout its range.

METABOLIC RATE AND THYROID HORMONES DURING THE ANNUAL MOULT OF GREY SEALS

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Measurements of oxygen consumption ($\dot{V}O_2$) in air at 20 °C and of serum concentrations of thyroid hormones were obtained from three juvenile and two adult grey seals (Halichoerus grypus) during the annual moult. All animals maintained a constant level of energy intake during the moult. The growing juvenile animals showed a clear increase (50% to 100%) in $\dot{V}O_2$ and in serum concentrations of thyroxine and triiodothyroxine. For these animals, the moult and the increase in $\dot{V}O_2$ occurred before the increase in thyroid hormone concentrations. This pattern of events suggests that the increase in $\dot{V}O_2$ for juvenile grey seals may reflect a thermoregulation problem in air during the moult. The adults, whose body mass decreased by 12 and 22% respectively, did not exhibit a clear increase in $\dot{V}O_2$; but like the juveniles they exhibited show an increase in thyroid hormone concentrations. These results, combined with the terrestrial behaviour of grey seals in the wild, suggest that the annual moult is very energetically challenging for these animals.

ABORTION, STILLBIRTH AND EARLY NEONATAL DEATH IN WEDDELL SEALS OF MCMURDO SOUND, ANTARCTICA

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Reproductive loss and pup mortality are important components of Weddell seal population dynamics in McMurdo Sound, Antarctica. However, little is known about specific underlying mechanisms. To better understand perinatal mortality we performed complete necropsies on 32 dead Weddell seal pups found during population surveys and during a pup growth study from October 15 through December 10, 1992. This represents 10% of the total pup production from the study area. Gross necropsies included a detailed collection of fixed tissues from unfrozen carcasses and frozen tissues from all carcasses. Based on gross observations seal pup mortality was categorized as: 3 (9.4%) abortions; 5 (15.5%) stillbirths; 10 (31.3%) early neonatal deaths with no gross lesions (pups with body fat estimated to have died within 24-48 hours); 6 (18.8%) starvation cases (age from 3-17days); 3 (9.4%) acute trauma cases; 4 (12.5%) pups with subacute-chronic suppurative lesions; and 1 (3.1%) 38-day-old pup with no gross lesions. Two of 4 dead pups from a closed population at White Island exhibited minor congenital defects that may be due to the expression of recessive genes. One had an anomalous external ear and the other had a shortened mandible and mild doming of the cranium.

The majority (56.2%) of the Weddell seal pup mortality in McMurdo Sound during the 1992 austral spring was identified as abortions, stillbirths, and early neonatal deaths not due to starvation. Further analyses of collected tissues are in progress.

SEX AND AGE STRUCTURE IN TWO SEA OTTER MORTALITY EVENTS

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In 1989 and 1990 two sea otter populations in the north Pacific ocean experienced significant mortality events. Following the grounding and release of oil from the T/V *Exxon Valdez* in March 1989, 674 sea otter carcasses were recovered from Prince William Sound and the Kenai Peninsula in southcentral Alaska. During the winter of 1990-91, 742 sea otter carcasses were recovered from the shores of Bering Island in Russia. The Alaska mortality event occurred in a population considered to be at or below equilibrium density, with unoccupied or recently occupied habitat adjacent to the spill area. The Russian mortality event occurred in an island population likely above equilibrium density with no available unoccupied habitat. The Bering Island population resulted from immigration from nearby Medny Island in 1971, numbered about 3500, and was rapidly increasing prior to the event. The Alaskan mortality event may be considered independent of sea otter density, while the Bering Island mortality event may be considered density dependent.

The sex and age class structures represented by those animals dying in each population differ significantly. In Alaska, 60% of the animals were female, while at Bering Island 19% were female. In Alaska, 32% of the animals were aged 0-1 years, 49% were 2-9 years, and 19% were > 9 years. From Bering Island, 12% were aged 0-1, 58% were 2-9 and 30% were > 9 years. The observed patterns may reflect a polygynous reproductive system that results in spatial partitioning of the sexes.

PRE-NATAL INVESTMENT IN REPRODUCTION AND AGE COMPOSITION OF NORTHERN FUR SEAL (CALLORHINUS URSINUS) FEMALES ON BERING ISLAND, RUSSIA

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Theory predicts that females of sexually dimorphic species give birth to smaller, energetically less expensive female offspring when they are young (small), and larger, more expensive male offspring when they are older (large) to ensure maximum survival. To test this concept data were collected on 4611 newborn northern fur seal (Callorhinus ursinus) pups (748 of which had mothers of known age) on Bering Island, Russia, from 1982-1992. Birth weights and lengths of 72 known aged mothers was obtained in 1992. Weights of male and females pups were positively correlated with the age of their mothers from 3-12 years of age (males, $n=240$, $r=0.42$, $p\leq0.0001$; females, $n=239$, $r=0.31$, $p\leq0.0001$). Only the birth weights of males were negatively correlated with the ages of mothers 13-22 years of age ($n=124$, $r=-0.21$, $p\leq0.01$). Survival of pups was positively correlated with their mass and length at birth and with the age of their mothers. Mortality was highest for pups whose mothers were 4-7 years of age or had immigrated from other islands. The percentage of male and female pup weight relative to the weight of their mothers was negatively correlated with maternal mass ($r=-0.68$, $p\leq0.001$) and age ($r=-0.49$, $p\leq0.001$). The average age of parturient females shifted from 14.2 early in the breeding season to 7.8 late in the season. There was no correlation between pup mass and mass of their mothers at parturition. Data from all years indicates that birth weights increase during the first half of the breeding season and decreases during the last half of the season. Newborn males ($x=6.1$ kg and 64.7 cm, $n=2284$) were 11% heavier and 3.6% longer than females ($x=5.5$ kg and 62.4 cm, $n=2327$). These results indicate that age of mothers plays an important role in the weights of pups, that age and weight plays an important role in survival, and that males require a greater investment of maternal resources.

MORPHOMETRIC COMPARISONS OF HARBOUR PORPOISE (Phocoena phocoena) SKULLS FROM THE SWEDISH BALTIC AND SKAGERRAK SEAS.

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We measured harbour porpoise skulls from animals incidentally taken in fishery operations or found stranded between 1970-1991, to assess whether separate stocks exists in Swedish waters. We measured 16 metric skull characters of 14 females and 17 males from the Baltic Sea and 25 females and 18 males from the Skagerrak Sea.

Analyses of covariance showed significant differences ($p<0,01$) in four characters for females and two characters for males in cranial morphometry. In general, females from the Baltic Sea had wider skulls and wider rostrums than their counterparts in the Skagerrak Sea. Males from the Baltic Sea were narrower at the base of the rostrum and had wider premaxillaries than males from the Skagerrak Sea.

The observed differences could be explained by the existence of a resident stock of harbour porpoises in the Baltic Sea or by a strong tendency for migrating animals to return to specific areas during the breeding season. Both explanations could produce reproductive isolation and result in separate stocks of harbour porpoises. This potential reproductive isolation suggests that harbour porpoises in the Swedish Baltic Sea should be managed separately from harbour porpoises on the west coast of Sweden.

INSIGHT INTO SPERM WHALE ECOLOGY AND BEHAVIOR IN THE MEDITERRANEAN SEA THROUGH ACOUSTICS.

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A series of cruises were organized in the Central Mediterranean Sea from 1988 to 1993 to investigate aspects of the ecology and behavior of sperm whales (*Physeter catodon*) in this region. Sounds were recorded using stationary hydrophones and towed hydrophone arrays to allow directional hearing, and were analyzed using real-time digital signal processing techniques. Objectives of the study included: 1) a description of the distribution of sperm whales, especially in consideration of the heavy bycatch connected with the swordfish driftnet activities, and 2) the description of the features of sperm whale vocalisations, including click rates, codas, usual clicks and creaks. Sperm whales were surprisingly scarce, suggesting a likely decreasing trend of this species in the study area. Most whales were encountered in loose aggregations greater than two animals in waters adjacent to the continental slope. In all regions only one distinctive coda was repeatedly heard, thus corroborating the hypothesis that codas might be a geographical marker. A distinctive acoustic behavior was recorded, involving the synchronisation of two whales vocalizing in a duet while being widely separated. The possible adaptive significance of such remarkable behavior is discussed.

INDIVIDUAL VARIABILITY IN ACOUSTIC FEATURES OF STEREOTYPED CALLS OF KILLER WHALES (*ORCINUS ORCA*)

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The repertoire of stereotyped calls produced by killer whales is thought to be relatively invariant within individuals and variable between pods. Unfortunately, the development of these stereotyped calls and the differences in call production among wild individuals are poorly understood. We examined the variability in acoustic features of stereotyped calls made by individual female captive killer whales held at Sea World's four parks. The pod of origin of wild-caught whales at Sea World is not known, but nearly all were caught off Iceland. If calls are passed with fidelity from mothers to calves, we hypothesized that the acoustic similarity in call types between mothers and their own subadult calves should be greater between mothers and other females, who would generally have come from different pods. We further hypothesized that the location of and age at capture would be good predictors of similarity among calls of mothers. Call types used in common were categorized by ear and analyzed using twelve acoustic features. All the calls were attributed to individuals either because the individual was isolated or because the call could be localized in air by a nearby observer. The call component that distinguished individuals best was a high-frequency component that overlapped other components of many calls. It is possible that this component functions as some type of signature. The similarities in acoustic features between mothers and their own calves were not greater than between mothers and other female calves raised within the Sea World parks. However, larger differences were found among the wild-caught females.

FINBACK AND HUMPBACK WHALES FROM THE GULF OF ST. LAWRENCE: BLUBBER FATTY ACIDS SUGGEST DIFFERENT DIETS

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Free-ranging finback (*Balaenoptera physalus*, n=19) and humpback (*Megaptera novaeangliae*, n=10) whales were sampled by biopsy in the Gulf of St. Lawrence, Canada, during summer and fatty acids extracted from the outermost blubber layer.

The two species differed in the chemical composition and stable carbon isotope distribution of their fatty acids. Finback fatty acids were slightly but significantly higher in 12:0, 13:0, i14:0, 16:0, 16:1 n5, 17:0, 18:0, 18:1 n9, 18:1 n7, 18:2 n6, 19:0, and 20:0, and had a $\delta^{13}C$ of -25.5 ± 0.4‰. Humpbacks contained more i16:0, 16:1 n7, i18:0, 18:1 n5, 20:4 n6, 20:5 n3, 22:5 n3, and 22:6 n3, and their fatty acid $\delta^{13}C$ averaged -25.8 ± 0.5‰. Cluster and principal component analysis were used to integrate and visualize the differences in the chemometric data sets. The results suggest a finback diet relatively rich in *Thysanoëssa raschii* and other euphausiid crustacea, with humpbacks consuming a higher proportion of schooling fish such as the capelin, *Mallotus villosus*.

ESTIMATION OF BODY WATER SPACE IN HARBOUR SEALS: HOW USEFUL IS BIOELECTRICAL IMPEDANCE ANALYSIS?

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Isotope dilution is an accurate but time-consuming and expensive way to estimate body water space (BW), thus limiting the number of animals that can be studied. We evaluated a bioelectrical impedance analyzer (BIA) for its potential to estimate BW in harbour seals. Deuterium dilution space (an estimate of BW) was determined in 12 adult females and their pups between birth and 20 days postpartum and 12 adult males captured early and 8 of these same males captured late in the breeding season. At the same time, resistance (Rs) and reactance measurements were taken from each animal using a tetrapolar, impedance plethysmograph (Model 101A, RJL Systems). Adults were sedated with diazepam prior to taking BIA readings. Within-day duplicate Rs measurements on adults, taken from 10-200 min apart, differed by an average of 6.4% (CV = 102%), with 6 of 31 duplicates differing by >10%. Movement by the animal had significant impact on the stability of Rs readings, as did electrode placement. We used stepwise multiple regression to derive predictive relationships for deuterium dilution space in adults and pups separately. Body mass and electrically determined biological volume (length^2/Rs) accounted for 92% and 98% of the variance in deuterium dilution space in adults and pups (excluding newborns), respectively. Predicted BW for 8 males not used to derive the adult predictive equation differed between 2.5% and -19% of the measured value, with a mean error of 1.8 ± 3.56 (SE)%. Rs measurements in all 3 newborns fell well outside the pattern of other pup data. Without further development, BIA measurements would appear to result in unacceptable errors in estimates of fat-free and fat mass of individual harbour seals.

FORAGING TIME BUDGETS IN ANTARCTIC FUR SEALS

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Antarctic fur seals forage on patchily distributed prey (Antarctic krill) which varies in abundance between and within years. We investigated how females structure their foraging, in terms of time spent foraging within patches, in response to changes in prey availability while also taking account of the limits imposed on foraging by the physiological diving capabilities of the species. A method was developed to divide foraging behaviour into logical units (bouts) and then to classify those units using statistical clustering. Four types of bout were recognised based on duration of bouts and the characteristics of the constituent dives. Dive depths, durations and swimming velocities were highly consistent within bouts suggesting that bouts were representative of foraging on specific prey patches. Different bout types occurred at different times of day probably in response to diel variation in prey patch distribution. One particular type of bout accounted for 61-73% of time spent foraging depending on the year. During one year when food was scarce, the greatest proportion of time was spent in this type of bout. Mean dive duration during bouts exceeded the theoretical aerobic dive limit on >50% of occasions for three of the four bout types. We conclude that the temporal arrangement of Antarctic fur seal diving is adjusted to changing patterns of food distribution and probably also in relation to profitability of particular food patches.

THE INTESTINAL ALLOMETRY OF ADULT PHOCID SEALS

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In an attempt to explain the functional significance of small intestine length in phocid seals, we examined interspecific intestinal allometry in adults from 8 species (ringed (*Phoca hispida*, n=7), harbour (*P. vitulina*, n=1), harp (*P. groenlandica*, n=17), grey (*Halichoerus grypus*, n=7), hooded (*Cystophora cristata*, n=1), crabeater (*Lobodon carcinophagus*, n=4), Ross (*Ommatophoca rossi*, n=1), and southern elephant seals (*Mirounga leonina*, n=18)) using least squares linear regression of $\log_{10}$-transformed data.

Small intestine length (l) varied as body mass (M) raised to the power 0.59, significantly greater ($p<0.05$) than that predicted by geometric similarity ($M^{0.33}$). For ringed, harbour, harp, and southern elephant seals, however, small intestine circumference (c) varied as $M^{0.17}$, significantly less ($p<0.05$) than that predicted by geometric similarity ($M^{0.33}$). This finding suggests that "basal" surface areas (l x c) of phocid small intestines vary as $M^{0.76}$, similar to values reported for terrestrial mammals, and is consistent with the hypothesis that small intestine length of phocid seals is a function of metabolic requirements.

ASSOCIATION PATTERNS OF BOTTLENOSE DOLPHINS *(TURSIOPS TRUNCATUS)* IN GALVESTON BAY, TEXAS

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Much research has been done on group and social structure of bottlenose dolphins (*Tursiops truncatus*). It has become apparent that there is certain fluidity in group membership of over one dozen populations studied to date. While a multi-male, multi-female mating structure has been inferred from some of this work, details of social structure and mating strategies are not yet worked out fully for any population. We report here on part of a population of dolphins of the ship channels of Galveston Bay, Texas. While over 1,000 dolphins have been individually identified in the past three years, only about 200 occur reliably in the area and may be termed "resident". Group sizes range from 1 to 30, with a mean of 4.4 ± 0.15 S.E. ($n = 552$). Association levels were calculated for 35 individual dolphins with 4 or more sightings in each of 1990 and 1991; with the Half-Weight Index $2N/(n_1+n_2)$, where $2N$ = the total number of joint sightings scored once for each occurrence of both individuals together, n_1 = the total number of sightings for the first individual, and n_2 = the total number of sightings for the second individual. Median association level was 0.154 in 1990 ($n = 165$) and 0.125 in 1991 ($n = 216$), comparable to findings of bottlenose dolphins in southern California, but smaller than indices found in Florida and Portugal. The weak patterns of associations indicate low long-term affiliations and especially high group fluidity, probably related to resident dolphins frequently mixing with non-residents which occur in the study area for only days to weeks.

MESOSCALE TEMPERATURE FEATURES AND MARINE MAMMALS IN THE GULF OF MEXICO

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In an attempt to characterize preferred habitats and to discover preferred depth ranges of cetaceans in the Gulf of Mexico, we combined data from the GulfCet project, a study of the distribution and abundance of marine mammals in the north-central and western Gulf of Mexico, with historical sighting data. Visual and acoustic data from four GulfCet cruises and two NOAA aerial surveys in 1992-1993 were used as well as hydrographic data from the GulfCet cruises. We were able to detect mesoscale features such as eddy Triton and eddy Vazquez from the hydrographic data of the GulfCet cruises. Isotherms at 15 and 20 °C have been computed from CTD and XBT data, and plotted for each cruise. We have superimposed the cetacean GulfCet sighting locations on this isotherm plot, and preliminary results indicate a possible association between some species and particular mesoscale features. To find the depth ranges preferred by cetaceans at each historical and GulfCet sighting point, we extracted depth by longitude and latitude from a bathymetry database (ETOPO 5). Although we combined historical and GulfCet data, the amount of data was sufficient enough for analysis on only four of the cetacean species. These species were: *Physeter macrocephalus* (Sperm whale), *Stenella attenuata* (Pan-tropical spotted dolphin), *Stenella frontalis* (Atlantic spotted dolphin), and *Tursiops truncatus* (Bottlenose dolphin). We divided the Gulf into seven depth ranges and calculated the percentage of sightings of each species in each range. Both *P. macrocephalus* and *S. attenuata* were primarily found in water over the continental slope and deeper water, with about 75% of both species at locations with depths greater than 1000 m. Both *S. frontalis* and *T. truncatus* were primarily found in water covering the continental shelf, with about 84% of both species shallower than 500 m. Because these last two years were uncharacteristic for the Gulf of Mexico, with the occurence of such events as large sea surface temperature anomalies and high flux of the Mississippi River into the Gulf, we suspect continued data collection over seasons will change these distributions.

BACTERIAL AND CHLAMYDIAL CULTURE RESULTS FROM STELLER SEA LIONS FROM THE GULF OF ALASKA AND SOUTHEAST ALASKA

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During 1992 and 1993, bacterial and chlamydial cultures were taken from Steller Sea Lions from Alaska. The cultures were collected from aborted fetues, live pups, and live, anesthetized adults. The sites cultured included lung, amnionic fluid, stomach, heart, liver, kidney, placenta, nares, eye, pharynx, mouth, vagina, and rectum. The cultures were plated onto TSA 5% Sheep blood agar; CNA 5% sheep blood agar, Macconkey agar, Brilliant Green agar and TCBS agar. A direct sample slide was prepared for gram stain. Chlamydial cultures were taken from eye, lung, vagina and rectal samples and cell cultured.

The gram positive organisms isolated included: *Staph sp.*, various *Strep sp.*, *Corynebacterium aquaticum*, *Micrococcus sp.*, *Bacillus sp.*, and *Listeria sp.* The gram negative organisms included: various *Pseudomonas sp.*, *Enterobacter sp.*, *Provendencia/Morganella sp.*, *Kluyvera sp.*, *Edwardsiella tarda*, various *E. coli*, *Plesiomonas shigelloides*; *Proteus penneri* and *mirabilis*, *Hafnia alvei*, *Vibrio fulvialis*, and *Salmonella saint-paul*. The gram stains showed a gram negative cork screw shaped bacteria, probably a *Campylobacter* and a gram negative spiral bacteria, possibly a *Borrelia* type organism. Chlamydial cutures isolated *Chamydia psittaci* from an aborted fetus.

Identification of normal bacterial flora and potential pathogens is important in understanding the effects of concurrent disease and environmentals factors in the decline of the Steller Sea Lion populations.

LENGTH, SEX AND REPRODUCTIVE DATA FROM MASS STRANDINGS OF THE LONG-FINNED PILOT WHALE, (GLOBICEPHALA MELAS), IN TASMANIA, AUSTRALIA.

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Length, sex and reproductive data were collected from mass strandings of long-finned pilot whales (Globicephala melas) on the Tasmanian coastline between 1935 and 1992. Results of this preliminary data were compared with studies of northern hemisphere G.melas which used data from mass strandings off the British coast and fisheries operating in Newfoundland and the Faroe Islands. Sex ratios of foetuses (46.9%) and post natal animals (F60.5%) are in agreement with those reported for Britain and Newfoundland (Martin et al. 1987, Kasuya et al. 1988). Maximum body lengths for males (6.15m) and females (5.08m) were similar to those reported for Newfoundland, and generally smaller than animals stranded on the British coast except for one Tasmanian stranding (Bridport, 1983) which had unusually large males (7.2m) and females (6.0m). Length frequencies and sex distribution were consistent for 8 of these 10 Tasmanian strandings, and indicate similar social structures for northern and southern hemisphere G. melas.

Females in the larger length classes exhibited high rates of lactation and correspondingly lower rates of pregnancy. This pattern is similar to that reported for the short-finned pilot whale, G. macrorhynchus, (Kasuya and Marsh 1984), however has not been reported for G. melas (Kasuya et al. 1988). Breeding is synchronised within, but not between pods, and occurs in all but three months of the year.

SYNCHRONOUS COORDINATION OF CREATIVE BEHAVIORS BY BOTTLENOSE DOLPHINS

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Wild dolphins perform a variety of non-stereotyped behaviors in synchrony. How they coordinate these behaviors is unknown. The current study used 2 captive dolphins to examine how they coordinated non-specified behaviors performed in synchrony. Non-specified behaviors were directed by a single gestural sign called "Creative". This sign instructs the dolphins to perform a behavior of their own choosing which is different from behaviors they have performed earlier in response to this sign. Another gestural sign, "Tandem," instructs the dolphins to perform behaviors together. The dolphins have to produce the same behavior at the same time. The results of this study indicated that the dolphins had developed a concept of performing creative behaviors in tandem. On these trials the dolphins performed behaviors judged to be "in tandem" 567 out of 698 times, $p<0.01$. A total of 83 different kinds of behaviors were performed when the Tandem + Creative were given together. A videotape analysis indicates that mimicry between the dolphins may play a role in behavioral choice and coordination in "Tandem Creatives".

TOLERANCE OF HARBOUR SEALS TO HUMAN RELATED DISTURBANCE SOURCES DURING HAULOUT

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A pilot study was designed to examine tolerance of harbour seals *Phoca vitulina* to human disturbance. At 20 haulout sites, seals were approached, in a standardized way, by different sources of disturbance until they entered the water. Parameters recorded were vigilance, by counting the number of seals with their head up before and after disturbing, the distances at which animals changed behaviour and distance at which they left for the water, and recovery over time.

The distances tolerated varied between 100m and 1800m depending largely on the source of disturbance. This correlated well with the distance at which they left for the water. In general seals occurring in areas which are often visited by man showed a higher tolerance than animals living in areas with less disturbance.

Although "head up" is considered to be a sign of vigilance, no apparent relation was found between this behaviour and the distance at which seals can be approached.

Of the 46 disturbances registered only in 25 cases some recovery was noted. Only two groups showed complete recovery.

It is of management interest to be able to evaluate the effect of disturbance on population parameters. The understanding of the tolerance to disturbance is an important component of in assessing impact of disturbance.

PRE-EXPLOITATION ABUNDANCE OF RIGHT WHALES OFF THE EASTERN UNITED STATES

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It has been assumed that large numbers of right whales were present in the western North Atlantic at the time of European colonization, but until recently there has been no quantitative basis for making an estimate of 'initial' population size. We reconstructed the catch history for the eastern United States 1630-1930 by reviewing literature and examining British archival records on whale oil and baleen imports from the American colonies, 1695-1734. An average yield of 600 pounds was applied to the baleen data to estimate landed catches, and a correction factor of 1.2 was used to account for whales killed but not secured. Population trajectories were calculated based on hitting a current population size of 350, with a simple population model (no age or sex structure) and a density-dependent recruitment rate. MSY rates (a measure of population productivity) of 0.01, 0.03 and 0.05 were used. The resulting trajectories indicate a population size > 1,000 in the mid 1600s and a slow increase since the mid 1700s. The population may have been reduced to as few as 100 whales in the mid 1700s. Since the catch history is incomplete, the 17th-century population off this coast may have been much larger than indicated in this analysis. Different hypotheses of stock identity, and inclusion of takes from 16th- and 17th-century Basque and other whaling around Newfoundland and in other areas, would appreciably change these provisional, conservative estimates.

SURFACE INTERVALS OF HUMPBACKS IN THE HAWAIIAN WINTERING AREA

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Ability to estimate abundance of whales from survey data is influenced by amount of time animals are at the surface to be observed. This factor is especially important during aerial surveys. Sightability may be influenced by number of animals in a pod, level of activity, and amount of time one or more whales are at or near the surface. Although respiration rates and surface times have been determined for humpback whales while on the summer feeding grounds, no data are available from the wintering areas.

Observations of humpback whales were made from January-April in two areas of Hawaii between 1991 and 1993; from small (ca. 4m) boats and an elevated (23m) shore station on the west coast of the Big Island, and from small boats near the south end of Maui. Pods were observed for a minimum 15 minutes while observation time, pod size, composition, location, activity, sighting condition, and time of day were determined.

Surface interval (SI) was documented for 183 pods from Big Island (boat=103; shore station=80) and 110 pods from Maui. Calves were present in 50.2% of the pods. Four whales or more were in 12% of the pods. ANOVA and post hoc comparisons were used to detect significant effects ($p<.05$) on SI. SI increased significantly as pod size increased, and the rate of increase was significantly greater on Maui than on the Big Island. There was no significant difference in SI for pods observed from the shore station and pods observed from the boats. There was no effect due to time of day.

In addition to enabling the development of a correction for whales missed during aerial surveys, the present data indicate differences in habitat use by whales between Maui and the Big Island.

ESTIMATION OF FOETUS MORTALITY IN NORTH ATLANTIC LONG-FINNED PILOT WHALES (*Globicephala melas*)

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To estimate foetal mortality, we analyzed data on foetus size distribution from long-finned pilot whales (*G. melas*) collected in the Faroe Islands (1986-88). We applied methods developed for stage-structured insect cohorts, by allocating foetuses into discrete size classes. The change in frequency of the size classes with time was then used to calculate a mortality estimate. For the period of linear foetal growth, the estimated survival probability is 0.668, corresponding to a mortality rate of $0.0015 day^{-1}$. This is the first use of this method for calculating foetal mortality, so the sensitivity of the result to sampling error and the definition of size classes is presently being investigated.

This mortality level is much larger than usually assumed; it reduces fertility estimates and will have to be taken into account in population models for this species, and possibly other toothed whales species for which fertility estimates are calculated from pregnancy rates.

THE QUESTION OF REINTRODUCING CAPTIVE MARINE MAMMALS: A MODEL FOR CONSIDERATION

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Reintroduction to the wild has been used to manage endangered or locally depleted populations of animals. Navy-organized workshops identified and evaluated basic requirements for the reintroduction of captive marine mammals in general and Navy marine mammals specifically. Findings imply that there is no compelling scientific reason to reintroduce non-endangered species. The Navy's marine mammals, and most marine mammals in public display and research facilities, are not endangered. However, the development of reintroduction techniques using Navy marine mammals could be applicable to the maintenance of endangered marine mammals in the wild. A reintroduction program must manage risks to a minimum and demonstrate concern for the animals reintroduced as well as the host population. A generic model for planning a reintroduction program was developed based on workshop findings and addresses elements including candidate selection criteria, behavioral modification, disease transmission prevention, post-reintroduction tracking, and research and development issues.

DIFFERENTIATION OF NORTH AMERICAN BELUGA WHALES USING MITOCHONDRIAL DNA SEQUENCE VARIATION

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The beluga (*Delphinapterus leucas*) is an odontocete distributed discontinuously in arctic and subarctic waters. Beluga whales migrate from wintering areas to river estuaries and surrounding areas where they spend the summer months. It is important for the conservation of beluga whales to determine if beluga summering in each geographic region represent separate genetic stocks or if one large genetic stock migrates to different regions. Beluga examined in this study came from 15 summering locations in seven geographic regions: Alaska, Beaufort Sea, Baffin Bay, west-north Hudson Bay, east Hudson Bay, southeast Baffin Island, and the St. Lawrence River. Beluga samples were obtained from aboriginal harvests in the various Arctic summering areas and from stranded animals in the St. Lawrence. To determine if these geographic populations are separate genetic stocks, 240 bases in the mtDNA control region were sequenced and analyzed for variability in 310 beluga whales. Results indicate geographic regions contain separate genetic stocks and also genetic stock subdivision within the southeast Baffin Island region.

SEX COMPOSITION AND SIZE OF MIGRATING HUMPBACK WHALE *(MEGAPTERA NOVAEANGLIAE)* PODS

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Most behavioural studies of humpback whales have focussed on the breeding or feeding grounds. This study investigated aspects of the behaviour of humpback whales migrating along the coast of eastern Australia.

Land-based surveys have been carried out from a headland in southeast Queensland since 1980, to monitor the recovery of the population from commercial whaling. The surveys ran from May to October during the northward migration in the years 1980, 1981, 1982, 1986, 1987, 1991 and currently in 1993. A total of 841 pods were observed during six surveys. Humpback whales appear to migrate in smaller pods than reported on the breeding or feeding grounds. Pod size ranged from 1 to 5 animals. Most whales travelled in pods of 1 or 2 animals (44.6% and 44.9% respectively) and occasionally pods of 3 (9.3%) or more (0.2%). Studies during the whaling period indicate that the humpback whale migration is segregated with respect to age and sex. Lactating cows leave the feeding grounds first, followed by immature females, immature males, mature males and females, and finally pregnant cows. However, there was no significant change in pod size over the survey period during the 1991 season.

In 1992 a biopsy project was carried out during the north and southward migration. A land-based team recorded pre-biopsy behaviour in the absence of human interference. Biopsy samples were obtained for 186 different individual whales including 63 complete pods, where all the animals in the pod were sampled. Sex was determined by PCR amplification using Y chromosome specific primers. Preliminary analysis suggests that some large pods (3 or more animals) consisted entirely of males. These pods were characterized by their aggressive displays and resembled the competitive pods previously described on the breeding grounds only. The results provide evidence for the formation of male dominance hierarchies during migration.

WALRUS RESPONSE TO OFFSHORE DRILLING OPERATIONS

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Walrus response to drilling operations in the Chukchi Sea was evaluated between June 25 and October 19, 1989. Aerial and vessel observations of walruses were conducted at three prospects in conjunction with acoustic measurements of the operations. Walrus response was evaluated before, during and after they passed the drillsite relative to various sound sources. Over 350 groups comprising approximately 4,500 walruses were observed in the prospects. Walrus response was greatest during ice management when the icebreaker crisscrossed the prospect. Animals moved deeper into the pack ice, where the noise level from the icebreaker was an estimated 15-25 dB above ambient (97 dB). Once ice management stopped or became more focused at the drillsite, walruses began to reoccupy formerly used areas. Under these circumstances, walruses displayed some behavioral responses which rapidly decreased beyond 0.46 km (0.25 nmi) from the icebreaker. Walruses showed little response to other drilling operations. These results show that walruses reacted to icebreaker activities, but responses varied according to the intensity of ice management. This variability offers opportunities to incorporate precautions to minimize disturbance to walruses during drilling operations.

DEVELOPMENT OF A LAND BASED OVER-THE-HORIZON (OTH) TRACKING SYSTEM FOR MARINE MAMMALS

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The study of long range movements of marine mammals using ARGOS satellite transmitters has been proved to be effective, but the system is costly to implement if a large sample size is required, and accurate locations are limited. As an alternative to this, a low cost OTH tracking system utilizing the High Frequency (HF) groundwave propagation phenomena is being developed for tracking pinnipeds. Because of the inefficiency of small transmitting antennas at HF, it is not generally considered as being a viable band for biotelemetry, but, using a specially designed antenna with a direct ground connection to the sea greatly improves transmission efficiency. Coded signals from a transmitter using such an antenna are detected by a direction finding correlator receiver, improving signal detection and enabling identification of individuals. Locations are then calculated using the bearing information retrieved from two or more such receivers and data are then smoothed using Kalman filters, the parameters of which will be based on animal behaviour data previously obtained with a short range VHF system. A tracking range of 150-200Km is possible, depending on sea state, with a bearing accuracy of 2.5° at 150Km, this being improved as range is decreased and with the application of the Kalman filters.

Such a system removes some of the restrictions often encountered with ARGOS and can provide location accuracies that are far superior, especially at closer range. The application of Kalman filters with parameters based on individual species behaviour has far reaching implications in all fields of animal tracking.

USE OF BLOOD PARAMETERS IN EVALUATING CONDITION OF JUVENILE CALIFORNIA SEA LIONS

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Blood parameters can reflect the condition of pinnipeds if values of healthy individuals can be distinguished from values of physiologically stressed individuals. The occurrence of 2,000 juvenile California sea lions (Zalophus californianus) in Monterey Bay, California, coincident with the El Niño event, provided a sample of apparently malnourished individuals. From June to October 1992, 33 California sea lions were captured, tagged, measured, and blood samples obtained. These data were compared with data from Zalophus of San Miguel Island, California collected during spring 1993. Total protein, blood urea nitrogen (BUN), glucose, hematocrit, fatty acid, and ketone concentrations were compared between groups. Mean concentrations of proteins and BUN were significantly greater in sea lions in Monterey Bay ($p<0.0001$ and $p=0.0002$, respectively). There was no significant difference in glucose concentrations between the two samples ($p=0.538$), and hematocrit concentration was significantly greater for sea lions at San Miguel Island ($p<0.0001$). Greater protein and BUN concentrations in the blood of sea lions in Monterey Bay indicate excessive protein metabolism due to prolonged fasting or starvation. Low hematocrit in 1992 Monterey Bay sea lions indicates malnutrition and anemia. Pooled values from San Miguel Island and from 1993 Monterey Bay juveniles will provide normal ranges appropriate for future reference. Because they are essentially the poorest competitors, monitoring the status of juvenile pinnipeds during environmental perturbation may be important as potential indicators of changing food resources.

VOCAL PATTERNS IN TWO CAPTIVE MALE BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*).

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This investigation demonstrates distinct patterns in the vocal activity of two *Tursiops truncatus* over a two-year study period. These patterns change in overall number and intensity between years, but remain consistent in form over 24-hour periods. Influences on these patterns include natural diurnal effects and human-induced activities. These influences diversely affect a small group of specific vocal categories. Patterns in vocal activity during the daytime have a direct relationship to Feed and Training sessions. Variations in patterns associated with vacuum sessions and the physical orientation of the *Tursiops spp.* on *Lagenorhynchus obliquidens* suggest a degree of adaptation. There were three specific vocal events that remained consistent over time and had no obvious relationship to human activity. These events, occurring at 04:00, 06:00 and 18:00, have a limited association to light/dark cycles. The early morning vocal patterns occilate in number of vocalizations produced until a peak during the morning chorus. There is a steady pattern of non-activity that is associated with photic and sleep cycles.

SEX AND THE SINGLE MALE: BEARDED SEAL MATING STRATEGIES OFF PT. BARROW, ALASKA.

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Bearded seals (*Erignathus barbatus*) produce an elaborate underwater song during the spring breeding season. It is thought that males produce the spiraling trills and that the songs are associated with mating behavior. It has been suggested that the calls are either a device for attracting females or for proclaiming territoriality to other males. Natural history parameters suggest that the most plausible male mating strategies are either lek display or female defense. In this study, the underwater spacing of vocalizing bearded seals was investigated off of Pt. Barrow, Alaska using passive acoustic location analysis to look for evidence of regular spacing (uniform or clumped) that would be expected in a lek. Results indicate that vocalizing males remain stationary for up to 105 minutes and that their spacing relative to one another is not significantly different from random ($p<0.05$). These results do not support a lek display hypothesis, but are consistent with a female defense strategy. Future studies of underwater bearded seal spacing should attempt to visually document the proximity of vocalizing males to females.

POPULATION STRUCTURE AND MIGRATIONS OF SPOTTED SEALS IN WATERS NEAR THE KAMCHATKA PENINSULA (RUSSIA).

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Three distinct populations of spotted seals occur (Phoca largha) in waters surrounding the Kamchatka Peninsula: 1) the Karaginskiy population occurring in the Karaginskiy Bay region of the Bering Sea; 2) the Kuril population found on the south point of Kamchatka and the Kuril Islands; and 3) the northern Sea of Okhotsk population. Prior to this study, the population identity of seals seasonally present along western Kamchatka had not been determined.

Based on aerial surveys conducted from 1982-1989, Burkanov hypothesized that seals migrate during June from the northern Sea of Okhotsk to river mouths along the western coast of Kamchatka, the northern Kuril Islands, and possibly the southeastern Kamchatka Peninsula, to feed upon salmon runs during July through October. In August 1992 we deployed four satellite-linked transmitters on spotted seals captured at Bolshaya River, in southwestern Kamchatka. Results confirmed that seals feeding in this area during the summer come from the northern Sea of Okhotsk population, but some use by the Kuril Islands population was also documented. This indicates that some mixing occurs during summer months. Additional studies of seal movements and genetics are underway, which should help to confirm and clarify population boundaries.

ESTIMATES OF HUMPBACK AND BLUE WHALE ABUNDANCE ALONG THE U.S. WEST COAST USING MARK-RECAPTURE OF IDENTIFIED INDIVIDUALS

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Estimates of abundance have been made for a number of cetacean species in recent years using mark-recapture statistics with naturally marked individual whales. Critical examinations of these estimates have often revealed a number of potential violations of the assumptions of these procedures that can severely bias the estimate. One of the most common violations is heterogeneity of capture probability by non-random sampling. Our initial efforts to estimate humpback and blue whale abundance along the California coast were severely biased because of this problem. We report on our recent research that estimates humpback and blue whale abundance. Two critical aspects of our approach were: 1) to clearly define the population or aggregation being estimated, and 2) obtain samples from this population that are representative and independent of each other. We were most successful in applying this approach to humpback whales. We determined that humpback whales feeding along the coast of California, Oregon, and Washington are part of a single intermixing feeding aggregation with little interchange with other feeding areas. We identified 265 and 399 unique humpback whales in 1991 and 1992, respectively, from multiple areas within this region. Mark-recapture estimates that used a variety of samples yielded consistent abundance estimates of about 600 humpback whales. Estimates of blue whale abundance were more complex because defining the "population" was difficult. We found an apparent offshore/inshore segregation of whales with limited interchange. A small sample of blue whale identifications obtained during line-transect surveys conducted systematically along the California coast out to 300 nmi provided the sample that was not biased by the geographic coverage of sampling efforts. When this sample was used, blue whale abundance was estimated at just under 1,000 animals.

DIVING BEHAVIOR AND FORAGING LOCATION OF FEMALE SOUTHERN ELEPHANT SEALS FROM PATAGONIA

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Our aim was to describe the free-ranging diving pattern and the location of foraging of pregnant female southern elephant seals, Mirounga leonina, at Península Valdés, Argentina. This colony is unusual in two respects: it is removed from deep water by a broad shallow shelf (350-630 km wide), and colony numbers have been increasing in recent years in contrast to numbers from other southern hemisphere colonies which are stable or in decline. Microprocessor controlled, geolocation-time-depth recorders were deployed on four females, recording a total of 15,836 dives (270 dive days) during the period February to April, 1992. Departing seals crossed the continental shelf quickly (53.4 - 60.5 hrs) and did not show signs of foraging until reaching deep water, due east of the colony in the South Atlantic Ocean. Diving was virtually continuous (93% of the time underwater) with overall mean (± sd) rates of 2.5 ± 0.2 dives/h, mean dive durations of 22.8 ± 7.1 min (maximun dive duration = 79 min) with 1.6 ± 0.6 min surface intervals between dives, and dive depths of 428 ± 197 m (maximum dive depth = 1,072 m). The diving pattern of females from Patagonia is similar to that of seals from colonies where numbers are decreasing (Macquarie stock) or are stable (South Georgia Island). Patagonian seals do not, however, feed in or south of the Antarctic Polar Front or in cold waters along the Antarctic coast, where seals from declining or stable colonies forage.

A LAND-BASED STUDY OF SOUTHERN RIGHT WHALES (*EUBALAENA AUSTRALIS*) IN SOUTHERN AUSTRALIA

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Southern right whales migrate from their sub-Antarctic feeding grounds to the coastal waters of southern Australia to calve and possibly mate during the austral winter months. This species was heavily exploited in the 19th Century and the Australian population is estimated currently at between 400 and 800 individuals, a small fraction of its pre-whaling size.

Recent study has shown that the Head of the Great Australian Bight on the far west coast of South Australia is the site of the largest and most consistent right whale calving ground. Each year, on average, 15-20 calves are born in this area and over 30 adult whales may be present between the months of May and October.

An on-going, land-based study of the behaviour and ecology of the right whales at this site began in 1991. Super-telephoto photographic identification has proved successful at this site and is providing information on intra- and inter-year site use. Approximately 80 individual right whales have been identified by this technique to date. Three calves identified in 1991 were resighted in 1992, confirming the ability of the technique to identify this age class. Several problems associated with the identification of right whales have been noted and the use of colour film for this work is recommended.

OBSERVATIONS OF MUDDING BY GEORGIA BOTTLENOSE DOLPHINS

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A specialized feeding behavior, mudding, was observed, photographed, and video taped during The Dolphin Project's quarterly censuses of bottlenose dolphin, *Tursiops truncatus*, in the coastal creeks, sounds, and bays of Georgia. Mudding is when dolphin(s) use a mudbank as an aid in catching small schooling fish. One or more dolphins rush toward a school of small fish, creating a pressure wave that forces the fish onto the mudbank. The dolphin(s) follow the fish up onto the mudbank, eat a few fish, and then, twisitng their bodies and pushing with their pectoral fins, slide back into the water. During a mudding bout, dolphins may beach only once or in excess of 20 times. The Georgia coast was divided into 54 zones which were surveyed using 1-3 transects. The Dolphin Project surveyed a total of 1035 hours during surveys (n=4) from April 1992 through January 1993. Mudding was observed 15 times. The average number of dolphins observed mudding together was two (range=1-7). Mudding events occurred in small tidal creeks along the entire coast of Georgia. Twelve events occurred at low tide, while the other three occurred during incoming mid, outgoing mid, and outgoing high tides. The coast of Georgia is covered in marshland and riddled with tidal creeks which have extreme tidal fluxes (range=2-3m). The reduced water volume in these tidal creeks during low tide and the predominance of mudbanks form natural barriers to fish. A single dolphin, as well as two or more dolphins foraging cooperatively, could increase foraging efficiency by feeding on trapped prey chased onto the mudbank.

OPTIMIZATION OF MATING BEHAVIOR IN SOUTH AMERICAN SEA LIONS

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The conflict of interest between the sexes over reproduction would be intensified in sexually dimorphic species with female defense polygynous mating systems and males capable to force copulations. In such species, males should attempt to maximize reproductive success at a low energetic cost while females should make the best possible social and reproductive choice based on safety and "good genes". Yet evidence supporting these simple theoretical predictions is scanty. Males of the South American sea lion, Otaria byronia, breeding at Península Valdés, Argentina, increased the frequency of intrasexual agonistic interactions, female oriented defense behaviors and genital exploration up to 10 times, associated to proximity to sexual receptivity of harem females. One week after arriving to the rookery: (a) 60 % of 56 marked females mated with males other those to whom they had associated at their arrival, (b) 34 % mated with more than one male while in estrous, and (c) 71 % minimize reproductive risks by associating to dominant males in high density areas. Our results suggest that males optimize reproductive effort by selectively defending receptive females and that females may have the opportunity to exert precopulatory mate selection even in adverse social and physical circumstances.

NORTHERN DISTRIBUTION RECORD FOR THE TUCUXI DOLPHIN

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Distribution of the Tucuxi dolphin (Sotalia fluviatilis) is well documented in the literature and extends from Santa Catalina on the Atlantic coast of Brazil north to associated waters of the Caribbean Sea off Panama. During manatee/dolphin aerial distribution surveys along the northeast coast of Nicaragua in 1992, 136 sightings of Tucuxi dolphins were recorded during 19 hours of flight time. The animals were located nearshore and in the coastal lagoons of the Miskito Reserve. The northernmost sighting was in the backwaters of Leimus Lagoon (14°35'31"N, 83°14'54"W). The discovery of Sotalia in Nicaragua documents the occurrence of a population more than 800 km north of the closest known range in Panama. Highest sinle survey count was 63 animals in May and group sizes ranged from 1 to 24 individuals, with a mean of 9.1 ± 7.5 (SD). The dolphins also were observed by boat on several different occasions during March, May and June. Local fishermen call these dolphin "Lam" and report that they are common in the area throughout the year. A dolphin discovered dead by fishermen was examined and positively identified as S. fluviatilis by teeth and skeletal measurements. Cause of death was not determined. There does not appear to be any direct hunting pressure exerted by local fishermen, however there is a possibility of accidental entanglement in gill nets frequently used in this area. Additional surveys, local educational programs, and a protection plan should be implemented to ensure the preservation of this population.

GEOGRAPHIC VARIATION AND CULTURAL EVOLUTION IN SONGS OF HUMPBACK WHALES IN THE EASTERN NORTH PACIFIC

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Songs of humpback whales (Megaptera novaeangliae) off Hawaii and Mexico were examined to determine whether they changed similarly in both areas during a single breeding season. Songs of 24 individuals were recorded off Kauai, Hawaii and Isla Socorro, Mexico during two time periods, 21 January - 16 February and 31 March - 20 April, 1991. Forty-seven acoustic variables were measured for each singer. Similar variables were grouped together into six categories. Mean values for each singer were compared among regions and periods using two-factor ANOVAs. Songs from both areas shared all of seven phrase types (distinct patterns of notes). All but three variables changed between periods in at least one area. Groups of similar variables displayed similar trends. Quantitative characteristics of song elements often changed by the same amount in each area, with little variation within and among individuals. Conversely, structures of song patterns often changed differently in each area. This analysis suggested that cultural transmission between whales off Hawaii and Mexico may be occurring during the breeding season. Alternatively, progressive changes in humpback whale song may be determined by two mechanisms: whales may be predisposed to gradually change certain features of song independent of cultural influences, whereas other features may be altered by cultural transmission and cultural evolution.

AN INDIVIDUAL-BASED MODEL TO PREDICT BIOLOGICAL INDICATORS FOR DELPHINID POPULATIONS

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Regulatory mechanisms for populations of delphinids were investigated with a model that keeps track of the age and reproductive condition of individual animals. We predicted correlations between population density and (1) the proportion of sexually mature females in the population, and (2) the average age of sexual maturity on the basis of a qualitative population model that assumes population growth is primarily regulated by juvenile survival rates, pregnancy rates, and maturation rates. Linear and non-linear density dependence was incorporated in the model; the shape parameter (z) for the generalized logistic population growth equation ranged from 1.0 to 12.0. We found that (1) the proportion of mature females in the population and (2) the average age at attainment of sexual maturity were positively correlated with population density when $z = 1.0$ or $z = 2.4$ for the pregnancy rate and maturation rate functions. The shape of the production curve could not be predicted from the functional relationship between the regulatory parameter and density. In fact, for all forms of density dependence, the MNP level relative to carrying capacity ranged from 0.57 to 0.85. Finally, we concluded that it is likely that multiple density-dependent parameters regulate population growth.

HAPTOGLOBIN CONCENTRATION IN PLASMA FROM STELLER SEA LIONS AT FORRESTER ISLAND AND THE ALEUTIAN ISLANDS, ALASKA.

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Haptoglobin (Hp) is a blood protein which has the function of combining stoichiometrically with free hemoglobin (Hb) to form a very stable complex. The specific, non-reversible binding to Hp effectively sequesters free Hb that has escaped from damaged or worn-out red cells. Among other blood proteins, the concentration of Hp increases considerably in response to infection, inflammation, tumor, or trauma, in what is known as the acute phase reaction. The analysis of Hp concentration is a very sensitve, although non-specific, indicator of diseased states and disease persistance, routinely used for diagnostic and prognostic assessments in human and veterinary medicine. We compared the concentrations of Hp in plasma samples from Steller sea lions at Forrester Island in southeast Alaska, where the sea lion population is stable, and the Aleutian Islands, where the population is declining. We found higher levels of Hp in the samples from the Aleutian Islands than in those from Forrester Island, which suggests a possible physiological stress in the Aleutian population. We are currently studying the possible causes of the decline in the Steller sea lion population that has been observed over the past 20 years at the Aleutian Islands.

ALTERNATIVE METHOD FOR BRYDE'S WHALE POPULATION ESTIMATION

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There are a wide variety of mathematical models to estimate abundance based on photo-identification using the capture recapture technique. These models are mainly applicable to easily identifiable species such as humpback whales. Some cetacean populations like *Balaenoptera edeni*, in which not all the individuals are obviously marked and is hard to identify individuals. For this reason an important portion of the population is not identifiable, thus affecting the population estimate. Here we present the aplication of a methodology based on the binomial and Poisson distributions using the proportion of identified individuals (capture) and the frecuency of resightings (recapture) of those individuals. The results obtained display that the population estimate for the Bryde's whale (*B. edeni*) in the Bahía de La Paz Gulf of California, México during 1989 to 1991 period were, with the binomial distribution, 168 individuals with a range of 145 to 199 interval ($P<0.05$) and for the Poisson distribution, 235 with a range of 203 to 279 ($P<0.05$).

METHODS FOR ANALYZING FOOD HABITS OF ALASKAN STELLER SEA LIONS (EUMETOPIAS JUBATUS) USING FISH BONES AND SCALES.

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Listed as a threatened species under the Endangered Species Act, the Steller sea lion (Eumetopias jubatus) population decline may be food related. Evaluation of the food limitation hypothesis requires that food habits information be obtained as rapidly as possible without causing harm to individual animals. Historically, pinniped food habits studies have been conducted by analyzing either stomach contents or fecal material. The advantage to using fecal material rather than stomach contents is that numerous food habits samples can be obtained with minimal effects on the species. It is also possible to quickly obtain a wide coverage of specimens in time and space. However, unlike most other pinnipeds, which pass otoliths that can be used to identify fish prey, Steller sea lion scats contain few otoliths. Therefore, the most reliable way to determine the presence of fish prey is by identification of other fish bones and scales. Both bones and scales provide information for identification of taxa, while scales also provide data on age and size of prey. Use of this approach requires sieving the scat sample, sorting and drying fish bones, and comparing fish bones to a bone reference collection. In addition, techniques for recovery and identification of fish scales from scats are being required. Since 1985 the NMML Steller Sea Lion Task has been collecting and analyzing sea lion scats with assistance from the USF&WS. Through 1991, three hundred scat samples have been collected and analyzed from the area between Prince William Sound and Agattu Island in the western Aleutian Islands. Based on these results some species, such as Atka mackerel (formerly unknown in the diet) and salmon (which may have been under reported due to lack of otoliths in samples) have been identified together with walleye pollock, as the major prey of Steller sea lions in the Aleutian Islands.

SEASONAL AND DIURNAL PATTERNS OF OCCURRENCE, BEHAVIOR, MOVEMENTS, TRAVEL SPEED AND ACTIVITY LEVELS OF DUSKY DOLPHINS OFF KAIKOURA, NEW ZEALAND

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Dusky dolphins were observed off the New Zealand coast on 308 days (77% of observation days) for a total of 661 hours (58.2% of observation hours). Of 434 dolphin groups, most (57%) were seen during only one two-hour observation period; only 26 groups (6%) were seen in four or more consecutive two-hour periods. Most sighting records (38%) were collected in summer and fewest (14%) in winter months. In summer, almost all sightings occurred in the nearshore area, while in winter sightings were clustered offshore and over the axis of the Kaikoura Submarine Canyon. Dolphin groups observed in winter were on average larger than those seen in other seasons. Winter observations were dominated by dolphins engaged in directional travel, while parallel-to-shore "zig-zag swimming" predominated in other seasons. Slow swimming and directional travel were usually observed early in the day, "zig-zag swimming" predominated later in the day. Mean routine travel speeds ranged between 1.26 to 3.38 m/s. Swimming speed did not vary significantly with season or time of day, but was related to behavior categories. Swimming speeds were greatest during "directional travel", slowest during "slow swimming", and intermediate during other behavioral categories. Dolphin groups moved offshore in late afternoon in fall and summer months, while groups observed in winter remained relatively far from shore all day.

USE OF GLOBAL POSITIONING SYSTEM (GPS) TO MAP MARINE MAMMAL DISTRIBUTION IN FLORIDA

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The Global Positioning System (GPS) is a satellite-based, electronic navigation and positioning system operated by the U.S. Department of Defense. The system currently uses 21 satellites to provide accurate position information worldwide, 24 hours a day. Use of GPS helps to eliminate much of the human error associated with plotting animal locations manually. Locations of marine mammals were plotted with GPS to study their abundance, distribution, and movement patterns. Much of this information for manatees, dolphins, and right whales in Florida comes from aerial surveys. The Trimble Pathfinder Professional GPS system was used to record the positions of manatees sighted on aerial distribution surveys and transect surveys in several areas around Florida. Waypoints were recorded for every group sighted, and the position of the plane was automatically recorded every 15 seconds. All positions were post-processed using differential correction to improve accuracy. Positions recorded closely in time were shown to be serially correlated. To determine the time interval at which positions are no longer correlated, two-dimensional, time-series correlation analysis was performed on stationary positions recorded every minute. Ten passes were made over known landmarks to test the accuracy of aerial GPS positions. Positional errors of the passes, both uncorrected and differentially corrected, were compared to the "true" locations. Maps of flight paths and animal locations were created using a Geographic Information System (GIS). The GIS was then used to calculate the area visually searched by the observers. These data were used to estimate animal density in those areas.

DO CETACEANS HAVE ELEVATED RESTING METABOLIC RATES?

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Basal metabolic rate (BMR) of mammals can be predicted from body mass (Kleiber, 1975). It has been widely suggested that marine mammals have resting MRs 2-3 x higher than this. However, more recently the elevation of cetacean RMRs has been questioned. One complicating factor which all previous studies have ignored is the potential costs of echolocation which have been shown to be significant in other species (bats). We aimed to determine the RMR of the Atlantic Bottlenose dolphin, *T. truncatus*, controlling for the amount of echolocation behaviour. An open-flow respirometry system was used to measure O_2 consumption (VO_2) of a captive male when stationed at the side of the pool, with and without eye-cups. The dolphin exhaled under a hood during each of these exercises. The number of breaths collected, time between breaths and % time echolocating was recorded. In a separate study, ventilation rates were measured by logging each breath and the dolphin's behaviour over 10 min periods.

The RMR when the dolphin was stationary with eye-cups was 111.3 ± 18.5 Watts, similar to that predicted for a 80-120 kg animal (90-122 Watts). Without eye-cups, the RMR was 186.4 ± 13.1 Watts which was significantly higher than Kleiber's prediction, but still only about half previous measurements. The cost for a stationary dolphin echolocating 100% of the time was predicted to be 1.83 x RMR. An equal amount of O_2 was exchanged per breath. Ventilation rate and behaviour were significantly correlated. VO_2 was predicted for a variety of behaviours and the RMR measured using this method was also similar to Kleiber's prediction (122.4 Watts). Many previous measurements of cetacean RMR have involved contact with the apparatus and/or confinement which may have caused stress. Moreover, none have accounted for the costs of echolocation. These factors may have produced elevation of the RMR.

OBSERVATIONS OF GRAY WHALES IN THE SOUTHERN CHUKCHI AND NORTHERN BERING SEAS OF ALASKA, AUGUST-NOVEMBER, 1980-91

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A total of 176 sightings of 488 gray whales (*Eschrichtius robustus*) were collected during 104.3 hours of aerial surveys in the southern Chukchi Sea and northern Bering Sea, east of the International Dateline, from August to early November 1980-91. Surveys were flown infrequently and effort varied considerably among years and between geographic areas. Gray whales were sighted in all areas where surveys were flown, with the exception of Kotzebue and Norton sounds. Sighting rates were higher in the northern Bering Sea than in the southern Chukchi Sea during every month except September, when survey effort was inadequate for comparison. Most gray whales were feeding (57%, n=276), as indicated by mud streaming from the whales' mouth or by the presence of conspicuous sediment plumes brought to the surface by bottom feeding whales. One calf was seen south of Pt. Hope in September 1987. Additional information on gray whales in and adjacent to the study area comes from incidental sightings made during research targeting other species. The combined data suggest that the southern Chukchi and Northern Bering seas support relatively high gray whale densities throughout late summer and fall.

SIZE: THE ONLY MALE REPRODUCTIVE STRATEGY?

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Common dolphins occur in large groups, often exceeding several thousand individuals. In contrast, the average and largest observed groups of bottlenose (32 and >500, respectively) and humpback (7 and 30, respectively) dolphins are considerably smaller. Though little is known of the population structures of any of these species, their different group sizes infer very different social and behavioural structures and organisation. Examination of incidentally captured dolphins provides some insights into the differing reproductive strategies used by the males of these three species.

For all three species, combined testis weights are better correlated with body weight than with length or a measure of robusticity ($^{weight}/_{length}$). Mature male common dolphin weight is only 10 % greater than that of mature females, but they are endowed with testes that approach 4.2 % of body weight. Mature male bottlenose dolphins are 30 % heavier than mature females and their testes average 1 % of body weight. Humpback dolphins show the greatest sexual dimporphism, mature males are 60 % heavier than mature females. They also have small testes, which average only 0.7 % of body weight.

Interpolations from these data and the relative group sizes of the three species suggest that males of each employ different reproductive strategies. The ability of males to physically dominate smaller males and prevent their access to females is probably more feasible and energetically less costly in smaller groups than in large ones. In contrast, the ability to mate with as many females as possible and/or to 'swamp' a competitor's sperm (sperm competition), may be the best male reproductive strategy in large groups.

DESIGN CONSIDERATIONS IN MODELLING AND MICROCOMPUTER BASED SIMULATIONS

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To model marine mammal behavior all environmental areas should be represented. These include atmosphere, air-water interface, hydrography, biological factors, and substrate. Providing this capacity, difficult on large mainframe computers, would require the application of new technologies for microcomputers. The specific technologies are transputers and multiputers. This coupled with Object Oriented Programming provides processing power to rival super-computers. The application of these should allow ample computing power for spatial analysis of all sample points, not just averaging over a grid. The creation of an Intelligent Data Base to aid in the parameter determination phase would allow a graphical sampling of specific regions. A statistical treatment of that data for model validation could then be performed. Computer hardware and software selection considerations are included.

SERUM TESTOSTERONE PROFILES OF ADULT MALE HARBOUR SEALS DURING THE BREEDING SEASON ON SABLE ISLAND, NOVA SCOTIA.

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Like most seasonally breeding mammals, harbour seals (*Phoca vitulina concolour*) exhibit marked changes in behaviour during the breeding season which are associated with changes in reproductive physiology. Concentrations of testosterone (T) were assayed from serum of 12 individually marked adult male harbour seals sampled weekly on Sable Island, Nova Scotia throughout the 1993 breeding season (May 20 to July 11). We also monitored mass changes and the incidence and severity of wounding at weekly recaptures, and haulout behaviour during daily beach surveys.

Seasonal testosterone profiles of individual males peaked at concentrations of 4-7 ng/ml in late May or early June prior to the appearance of oestrus females. This was followed by a gradual decline during the mating period, falling to about 20% of peak levels by early July. Males expended considerable amounts of energy in reproductive effort over the breeding season as evidenced by the loss of up to 28% of initial body mass during the period following peak T concentration. The frequency and intensity of agonistic interactions increased sharply during the mating period (i.e., after T concentration peaked) as judged by the increased incidence and severity of wounding on the neck and hindflippers of males.

PATTERNS OF ASSOCIATION OF MALE BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN MORETON BAY, AUSTRALIA

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Recent work has shown that subgroups of two or three male bottlenose dolphins remain in constant association over several years, and that these subgroups co-operate in first and second order alliances to herd females. The onset of sexual maturity in the form of bottlenose dolphin found in Moreton Bay can be determined by external examination of the ventral surface. This study examined patterns of association of male bottlenose dolphins while feeding, emphasising age-related differences in association patterns.

Dolphins were observed from 1984 to 1987, and their dorsal surfaces were photographed to identify individuals from natural marks. Twenty-six males of known maturational state, identified on more than eight occasions during at least one year, were used in the analysis. A matrix of associations of these animals was constructed using a modification of Schaller's association index, and analysed using principal co-ordinate analysis.

Most mature males formed close associations with one, two or three other males at a similar stage of maturity, and some of these subgroups remained stable over the years of the study. Unquantified behavioural observations indicate that these close associations are alliances, similar to those described elsewhere. Immature and maturing males occurred in larger and more diffuse aggregations, and associations between some maturing animals became closer over time. These results demonstrate that ecological and ontogenetic factors influence the formation of alliances of male bottlenose dolphins.

SEASONAL CHANGES IN THE FIELD METABOLIC RATE OF BOTTLENOSE DOLPHINS, *TURSIOPS TRUNCATUS*.

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The bottlenose dolphin, *Tursiops truncatus*, is the most extensively studied small cetacean, yet we know very little about their food or energy requirements in the wild. Here we report the first direct measurements of the energy requirements of a free living cetacean using the oxygen-18 doubly labeled water method. Studies were carried out in Sarasota Bay, Florida where the entire resident population is known and individuals can be reliably captured and recaptured. In this study animals were captured, dosed with isotopes and recaptured 4 to 9 days later. Measurements were completed on 4 females and 1 male during June 1992, 2 males during February 1993 and 5 males during June 1993. Although we are waiting for final isotope analysis, preliminary data indicate that the 1992 summer animals had metabolic rates of 5.24 W/kg compared to the winter animals which had metabolic rates of 4.27 W/kg or 4.2 & 3.1 times resting rates measured for this species. These metabolic rates are quite similar to equivalent measurements carried out on 4 species of sea lions and fur seals and suggest that like these species dolphins have a energetically expensive lifestyle. Supported by NSF grant #OCE 9018626 & ONR grant #N00012-91-MD24G40.

REPRODUCTIVE HORMONE PROFILES OF FALSE KILLER WHALES USING A VARIETY OF BODY FLUIDS

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This project is looking at the basic reproductive endocrine patterns of the false killer whale, Pseudorca crassidens for which there are no reports in the published literature. Three captive females are the subjects for this study. As a novel approach, copious bodily fluids believed to contain the metabolites of the bloodborne hormones are collected biweekly concomitantly with blood; these include salivary, ocular, and vaginal secretions. The concentrations of progesterone and estrogen are measured and correlated in each fluid by validated radioimmunoassays. The alternate use of noninvasive methods of sampling is assessed for future routine monitoring of the false killer whale reproductive status. Techniques to normalize for possible seawater contamination in each secretion are being considered. Each fluid is analyzed for inorganic ion content and compared to seawater.

Preliminary results indicate that this species is a seasonal breeder that ovulates spontaneously during spring and summer.

THE BEHAVIOURAL DEVELOPMENT OF HARBOUR SEAL PUPS IN THE MORAY FIRTH, N.E. SCOTLAND.

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Studies of Harbour seal pup behaviour have focused on terrestial activities during lactation. In contrast, little is known of the development of pup feeding and diving behaviour post-weaning. This study aims to integrate quantitative data on the development of pup behaviour during lactation with information on post-weaning foraging and diving behaviour. In particular we aim to examine pup survival strategies during the first year.

Observations of the activities of mother-pup pairs were made at a site in the Moray Firth during 1992 and 1993. Three pup age categories were established based primarily on pup locomotor skills, and data were collected on activity budgets, suckling durations and maintenance of pair bonds. Initial results suggest that as pups age they become less active and suckle for longer durations, and that mothers become less vigilant.

Weaned pups, aged from 3 to 5 months, were fitted with VHF radio-tags, and data collected on activity and dive patterns. Juveniles and yearlings were captured regularly during their first year for analysis of growth rates. Faecal samples and enemas were obtained for diet analysis. At 3 months old juveniles appear to use similar feeding areas and have a similar diet to that of adults in this study area.

A CAPTIVE HARBOUR SEAL FEEDING STUDY EXAMINING THE POTENTIAL OF INCORPORATING CERTAIN FISH HARD PARTS INTO PREY IDENTIFICATION OF SCAT REMAINS.

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Previous studies have shown that otoliths in pinniped scats can be identified to the species level. The limitations and biases of faecal analysis using otoliths has been widely documented and as a result has limited its usefulness. Such shortcomings have facilitated the need to develop new techniques to verify the type, size, and number of prey consumed. Other fish hard parts have been used in prey identification but distinctive structures from specific species have yet to be catalogued. My study examines the potential of incorporating certain fish structures into dietary analysis and the statistical importance it plays in overall prey identification. Four harbour seals, aged 4-10 years, were fed 5-10% of their body weight per day with known numbers of different species of prey in 5-15 day experimental intervals. The seals were housed in continuous flowing salt water tanks 5 X 5 X 2m. Every 24h the faecal material was removed from the tanks using 0.496 mm sieves attached to the drains. Five species of fish (pollack, hake, salmon, herring and smelt) were tested for otolith and hard part recovery rates. Over 4500 fish were consumed during the 6 month experimental period. Preliminary results indicate certain fish have species specific hard parts which regularly occur in scat remains. These structures improve identification rates based solely on otoliths by as much as 20% for some species.

INVOLUTION AND CYSTIC TRANSFORMATION OF THE THYMUS IN THE BOTTLENOSE DOLPHIN, TURSIOPS TRUNCATUS.

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The thymus glands of ten bottlenose dolphins, Tursiops truncatus collected on the Texas Gulf coast were examined using standard histologic methods and immunocytochemistry. The thymus of Tursiops persists into adult life, represented by medulla and progressively thinning cortex. A network of epithelial cells, including Hassal bodies, is demonstrable using polyclonal anti-keratin antibody. The network condenses with loss of lymphoid cells as involution progresses. Cysts arise within the condensed network. These cysts, found in eight of 10 animals, increase in number and size with body size, tending to reflect age. They typically have an irregular shape when small, but tend to become spherical as they enlarge. They may be lined by squamous epithelium of varied thickness. Eventually, the cysts become macroscopic and filled with a colloid-like material, and may largely replace the thymus, which may be identified by non-cystic remnants adjacent to the cysts.

DENSITY-DEPENDENT GROWTH OF JUVENILE HAWAIIAN MONK SEALS (MONACHUS SCHAUINSLANDI)

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The largest population of Hawaiian monk seals, at French Frigate Shoals (FFS), may have reached carrying capacity after 30 years of increase. We tested this hypothesis by comparing the size of weaned pups, 1-, and 2-yr-old seals at FFS with the same age groups at Laysan Island, where the population is one-third of its historical maximum. Differences in axillary girth, standard length, and mass were evaluated using two-factor (island, year) MANOVAs for weaned pups and 1-yr-olds in 1991-93 and 2-yr-olds in 1991-92. For seals measured both as weaned pups and as 1-yr-olds, interisland differences in growth were tested using MANCOVA, with weaning girth, length, and mass as covariates. To assess the significance of smaller size, we also examined the relationship between axillary girth (measured at weaning) and survival of 379 pups born at FFS from 1984-91.

Results indicate that relative to seals at Laysan Island, 1) seals at FFS were significantly smaller at weaning and 2) the difference increased with age. Thus, increasing population density appears to compromise both adult females (smaller weaning size of pups) and juveniles (reduced growth from weaning to age 2). Also, observed survival rates declined with pup size from 0.9 yr^{-1} for seals with girth > 110 cm (n = 133) to approximately 0.5 yr^{-1} for seals with girth < 90 cm (n = 21). Hence, smaller size of seals at FFS leads to a reduction in survival, thereby providing a mechanism for density-dependent regulation of this population. Importantly, the smaller size and subsequent reduction in survival supports rehabilitation and translocation of undersized seals as a management tool to enhance the recovery of the Hawaiian monk seal.

DIRECTIONAL ASYMMETRY IN ODONTOCETE FOREHEADS.

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Asymmetry that arises in organisms as a result of imprecision in, or perturbation of the developmental process is referred to as *fluctuating asymmetry*. Fluctuating asymmetry varies in magnitude and direction across populations. *Directional asymmetry* is consistent in magnitude and direction across populations. Where it has been studied, directional asymmetry tends to be small in magnitude (less than 10%). Odontocete forehead asymmetry is primarily directional but can be relatively large in magnitude and varies with the species in question.

A ratio of left/right asymmetry was measured from CAT scans of postmortem odontocetes and from skulls in museum collections. Specimens from every extant odontocete superfamily were included in the analysis. Values for bony asymmetry were less than those for soft tissue asymmetry. Forehead soft tissue asymmetry appears to be centered around specific bilateral regions (monkey lips/dorsal bursae complexes) thought to be responsible for sonar signal generation.

Specimens were grouped into extremely, moderately, and slightly asymmetric classes according to a devised index. All physeteroids were classified as extremely asymmetric. Every other superfamily had at least one slightly asymmetric member and within the Delphinoidea, all phocoenids were classified as slightly asymmetric.

The function(s) of odontocete forehead asymmetry have been pondered for centuries. This directional asymmetry may, 1) produce an asymmetric sound field in order to reduce left-right ambiguity in the sonar problem, 2) be the result of functional separation (breathing vs. sound production) between left and right nasal passages, or 3) reflect specialization of biosonar signal generators.

IS SELF-REPORTING OF MARINE MAMMAL INTERACTIONS A USEFUL MANAGEMENT TOOL?

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In the 1988 amendments to the Marine Mammal Protection Act (MMPA), Congress initiated a five year Interim Exemption for Commercial Fisheries. The exemption program allowed for an unlimited number of marine mammals to be taken incidental to commercial fishery operations, provided that fishermen register with the National Marine Fisheries Service (NMFS) and submit logbooks detailing when and where fishing occurred, what types of gear were used, and how many and what species of marine mammals were involved in interactions.

Spatial/temporal patterns of reported marine mammal interactions will be presented. For those fisheries for which observer data were available, verification of fishery logbooks was performed to determine whether all active fishermen reported, whether fishermen reported all observed trips and takes, and whether reported take rates were similar to those reported by observers. On average, 75% of registered fishermen submitted a logbook. For those fishermen that both submitted logbooks and were observed, 78% of the observed trips and 49% of the observed takes were reported by fishermen. Mean self-reported take rates ranged from 0.00005 to 0.0211 takes/hour, as compared to observed take rates of 0.00014 to 0.0191 takes/hour. On a fishery by fishery basis, logbook take rates were from 0.3 to 13.6 times that reported by observed.

Verification of logbooks has shown that self-reporting underestimates, on average, marine mammal takes as compared to observer reports. However, fishery logbooks are a useful management tool for the characterization of fishery operations (especially spatial/temporal patterns of interactions). The use and modification of fishery logbooks to achieve future management objectives will be discussed.

BRONCHIAL SPHINCTERS IN DOLPHINS: DIFFERENT ACTIVITIES, DIFFERENT MORPHOLOGIES.

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The existence of mioelastic sphincters in the terminal airways of some cetaceans is known. But, do all of them have the same morphology?. If different, could those differences be related to different diving activities?.

Using light microscopy, histological serial sections of lungs from *Pontoporia blainvillei* and *Lagenorhynchus obscurus* were studied, clearly showing different sphincters in terminal airways. In *P.blainvillei*, a shallow diver dolphin, the mioelastic sphincters are thin rings with irregular distribution which occasionally strangle the airway. *L.obscurus*, with deeper dives and faster vertical displacements, presents thicker sphincters with regular distribution, generally strangling completely the airway.

We conclude that these morphologies can be related to different functional requests. We suggest the existence of two groups of dolphins, one of shallow divers, small cetaceans with less developed sphincters whose functional activity is uncertain, and another group with a wider diving range, having strong and functional sphincters.

It may be possible to say in a near future, with more data of different species: Tell me what kind of sphincters you have, and I'll tell you how deep you dive.

CONSTRAINTS ON REPRODUCTIVE EFFORT IN FEMALE NORTHERN ELEPHANT SEALS

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Physiological constraints play an important role in determining the magnitude and duration of reproductive effort (RE). We examined the energetics of lactation in the northern elephant seal, Mirounga angustirostris, to assess the effects of maternal mass and body condition on RE. Mass and body composition change, milk composition, and milk intake were measured in 17 mother-pup pairs at the beginning and end of lactation during 1991 & 1992 at Año Nuevo, California. Maternal body composition was assessed using an ultrasound scanner. Pup body composition and water flux were measured by isotopic dilution. Milk intake was calculated from water flux and milk composition. RE was assessed by measuring maternal energy loss, milk energy, and energy stored by the pup.

Initial maternal mass was positively correlated with maternal energy expenditure (r = .660). Initial maternal body composition was significantly correlated with mass-controlled energy expenditure (r = .704). Females terminated lactation at similar body compositions (23.1 $\pm$ 1.4% adipose tissue). Maternal energy expenditure was not significantly correlated with milk energy, suggesting differences in metabolic overhead and the efficiency of milk production. Milk energy was significantly correlated with pup energy gain (r= .784). The data suggest direct effects of maternal mass and body composition on RE. These effects are an important consequence of a life history that separates lactation from foraging.

POPULATION DYNAMICS OF ANTARCTIC FUR SEALS AT SOUTH GEORGIA, PAST, PRESENT AND FUTURE

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Antarctic fur seal numbers have been increasing at South Georgia for at least 35 years and now represent >90% of the world population. Evidence from changes in the distribution of breeding fur seals at South Georgia suggests that the population is expanding along coastline out of core breeding areas but that the rate of increase in the population is declining. Evidence from (1) mortality rates in the first four months, (2) age at first pupping in mothers, (3) growth rates of pups during lactation and (4) pup production within core breeding areas provide only equivocal evidence of density-dependent factors beginning to regulate numbers. However, the age structure of adult females has shown a gradual decline in the mean age which indicates either high recruitment to the adult population with low adult mortality or low recruitment to the adult population with high adult mortality. Observed survival rates of adult females, derived from the rate of return of tagged females to their pupping sites, suggest that there is high adult female mortality associated particularly with occasional catastrophic reductions in food abundance. Analysis of the population dynamics shows high sensitivity to periodic increases in adult mortality. We conclude that density-dependence may only be a significant factor regulating the size of the Antarctic fur seal population during unpredicatable and density-independent catastrophic declines in the food supply.

SWIMMING MOVEMENTS OF TWO CETACEANS: HARBOUR PORPOISE AND ATLANTIC WHITE-SIDED DOLPHIN.

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Dynamical swimming parameters, including swimming speed, fluke oscillation frequency, stride length, maximum heave and pitch angle of the flukes, and chordwise and spanwise fluke flexibilities were measured from videotape records of steady swimming for a harbour porpoise (Phocoena phocoena) and an Atlantic white-sided dolphin (Lagenorhynchus acutus). A linear relationship was found between swimming speed and fluke oscillation frequency. Stride lengths were significantly different between the two species. The periods of upstroke and downstroke of the flukes were equally long for all speeds measured. The harbour porpoise travelled at a slower absolute speed than the white-sided dolphin for any given frequency, but swam at a higher speed relative to its body length. The white-sided dolphin showed greater chordwise and spanwise fluke flexibility than the harbour porpoise. The different relative speeds, stride lengths and fluke flexibilities displayed by the two animals may be due to morphological and behavioural differences between the species.

POTENTIAL IMPACTS OF ECO-TOURISM ON MANATEES IN FLORIDA

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Florida's growing human population, concentrated along the state's coastal waterways, has exposed the endangered Florida manatee (Trichechus manatus) to unique threats unusual for a marine mammal. While increased protection measures and public awareness efforts have focused on reducing human-caused deaths and protected essential habitat, new problems have developed. Throughout the state, manatee aggregation sites are visited by a growing number of tourists and local residents attempting to view, feed, and swim with manatees. This often results in incidents of harrassment or disturbance, which can force manatees from resting and feeding areas, or warm water sites. Many individual manatees are becoming progressively tame, approaching boats and sightseers, thus increasing their vulnerability to injury or death. Increased effort is needed to assess the impact of unregulated public access to manatees. Well-planned manatee viewing areas should be designed with minimal disturbance to manatees at aggregation sites. Although existing protective measures have been directed towards water-related activities, measures controlling shore-based disturbances should be implemented.

AN ECOLOGICAL STUDY OF A COMMUNITY OF BOTTLENOSE DOLPHINS IN THE MORAY FIRTH, N.E. SCOTLAND.

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This ongoing photo-id study began in 1989 with the long term aims of determining the size, status, residency and social structure of this the only known community of bottlenose dolphins in the North Sea.

100 systematic boat surveys were carried out year-round in the inner Moray Firth. Between 84 and 124 individuals were identified in each year. Schools ranged in size from 1-46 (mean 6.6). Recognisable individuals were seen throughout the year but numbers peaked in inshore areas during the summer months. This accompanied the appearance of neonates and increases in surface feeding on salmonids. Sightings of dolphins throughout the study were clumped around three distinct topographically similar areas.

73 individuals were seen regularly in the inner Moray Firth throughout the study. Dolphins were also reported up to 225km from the main study area and, where photo-identified, were among the same 73. This suggests that the Moray Firth contains the most northerly (57°N) known discrete and philopatric community of bottlenose dolphins.

GENETIC VARIATION WITHIN AND AMONG POPULATIONS OF THE BOTTLENOSE DOLPHIN (*Tursiops truncatus*)

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Direct sequencing of the control region of mt DNA was used to examine variation in bottlenose dolphins (*Tursiops truncatus*) from the eastern North Pacific, western North Atlantic, and Gulf of Mexico. Geographic variation in small cetaceans is often extreme, even over short distances, and phylogenetic relationships among bottlenose dolphin populations with both allopatric and sympatric distributions are unclear. Inshore and offshore forms of bottlenose dolphins are commonly recognized based on morphological and ecological evidence, and some investigators postulate the existence of multiple local populations inshore. To investigate population structure of this species, total genomic DNA was isolated from tissue samples of 40 individuals representing animals from different ocean basins, inshore/offshore forms, and local coastal populations. A portion of the mt DNA control region was amplified using polymerase chain reaction (PCR) procedures, and dideoxy solid phase sequencing of biotinylated PCR product was performed. Genetic divergence was examined using AMOVA, a public-domain software program for analysis of variance testing. Preliminary results indicate that control region sequences maintain varying levels of polymorphism with greater differences between individuals having allopatric distributions.

CONCENTRATION OF METALS IN THE TEETH THROUGH THE AGE IN SAMLES OF SEA LIONS: ZALOPHUS CALIFORNIANUS CALIFORNIANUS RECOLLECTED BETWEEN 81 TO 91 IN THE GULF OF BAJA CALIFORNIA MEXICO.

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The literature information about heavy metals reports that they accumulate through the time in the organisms. The objective of this work is to report the concentration of 11 metals in the teeth of the common sea lion in 20 samples of all ages, recollected on the beaches of the Gulf of Baja California. The samples were washed, digested with acids, and the readings were made by a spectrophotometer equipment. We observed that the **Al** was the metal more concentrated in both female and male samples, with a mean of 86 ppm, **Ni** had 14ppm, the **Ca** in females were 500 times bigger than in the males. The **As** had the minor concentration with 2.5 ppm of all the samples. The mean of all the metals concentration were of 22 ppm in all ages. The **Al** accumulation in males is higher than in females. The ages that accumulate more metals like **Al** were between 10 to 12 years old. The **As, Cr, Ca, Cd, Zn, Ni, Mn** do not increase their accumulation through the years in the samples. The **Fe** has high variability of concentration. We propose to continue this work with more samples, and using structures with less time of being recollected.

EFFECTS OF THE EXXON VALDEZ OIL SPILL ON CETACEANS
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Baseline biological data on most cetaceans in Prince William Sound were lacking prior to the Exxon Valdez oil spill. However, sufficient information was available on humpback and killer whales. Study objectives were to compare whale abundance, distribution, and mortality rates before and after the spill. Humpback whale counts for 1989 and 1990 were higher than that reported for pre-spill years. Although some changes in distribution were noted, it was impossible to correlate these changes with the oil spill. No stranded humpbacks were found. Overall number and distribution of killer whales was similar to that reported for 1984 through 1988. However, 14 killer whales were missing from the resident AB pod (7, 6, and 1 in 1989, 1990, 1991, respectively). The missing whales are presumed dead based on our knowledge of their social structure. The highest mortality rates ever reported for killer whales occurred in 1989 (19.4%) and 1990 (20.7%), which coincides with the Exxon Valdez oil spill. However, there is no clear cause and effect relationship between the missing whales and the spill.

INTERACTIONS OF SMALL CETACEANS WITH COASTAL FISHERY ACTIVITIES OFF NORTHERN RIO GRANDE DO SUL STATE COAST, SOUTHERN BRAZIL
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A survey of interactions between small cetaceans and coastal fishery activities has been conducted in the northern coast of Rio Grande do Sul, southern Brazil, since October 1991. In order to obtain information on the nature and magnitude of these interactions, we carried out eleven cruises onboard artisanal fisheries vessels from the communities of Torres (29°19'S, 49°43'W) and Tramandaí/Imbé (29°58'S, 50°07'W). In addition, twenty coastal surveys have been conducted along 255 Km of the beach study area, from Torres to Mostardas (31°15'S, 50°54'W), covering a total of 1,704 Km, between October 1991 and April 1993. The incidental catch of small cetaceans was verified through direct observation of four franciscanas, Pontoporia blainvillei, entangled in gill nets during commercial fishing in the area. Furthermore, specimens of P. blainvillei (57), Tursiops truncatus (06), Steno bredanensis (02), Delphinus delphis (01) and Stenella coeruleoalba (01) were found dead along the coastal study area.

FOOD AND FEEDING OF GRAY WHALES OFF VANCOUVER ISLAND
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The food species, feeding "grounds", and "grazing" patterns of gray whales off Vancouver Island were investigated. Records of feeding locations, behavior and food species from 1975-1993 were analyzed, and in 1992-93 food species were collected from March to October. Food species were collected by plankton tows, suction hoses, and low tide excavations in the near vicinity of feeding whales. Vancouver Island gray whales feed on a variety of organisms including herring eggs (possibly larvae), several species of crab larvae, benthic and pelagic amphipods, mysids, ghost shrimp, and possibly juvenile fish. Food types change as the feeding season progresses. Feeding "grounds" are specific to a food type and its time of abundance, with some areas used regularly, and others sporadically. Gray whales feed at the surface, in the water column, and on the substrate. The common description of gray whales as bottom feeders is a simplification, and the delineation of specific feeding "grounds" is complex. Vancouver Island gray whales utilize a variety of food species, with little overlap with human fisheries.

AN ANALYSIS OF TISSUES FOR TOTAL PCB AND PLANAR PCB CONCENTRATIONS IN MARINE MAMMALS STRANDED ALONG THE GULF OF MEXICO
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New methods developed for extracting blubber by maceration of tissue in methylene chloride and subjecting the extract to gel-permeation chromatography, provided a quick, reliable alternative to classical methods used for analysis of organochlorine residues in marine mammal tissues. Due to the lipophilic nature of PCBs, tissues high in lipid content, such as blubber, give the best estimation of total body burden for the contaminants analyzed. Toxic Equivalents and baseline concentrations of total and planar PCBs in *Tursiops truncatus* which stranded along the Gulf of Mexico were determined. Data suggests that concentrations of total PCBs and planar PCBs are not correlated, hence samples must be analyzed for both compounds in comprehensive studies. PCB levels were statistically similar in three marine mammal species investigated. Little correlation was observed between PCB concentrations and stranding condition, stranding location or stranding year; however, a strong correlation was observed between the levels of PCBs, and the maturity and gender of the specimens analyzed. This trend suggests that PCBs can be used as a chemical tracer in evaluating several biological and reproductive parameters of odontocete species. Finally, preferential distribution of PCBs in different body blubber areas of *T. truncatus* was not observed due to the homogeneous distribution of lipids in the thin blubber layer.

OBSERVING THE UNDERWATER BEHAVIOR OF ELEPHANT SEALS AT SEA BY ATTACHING A SMALL VIDEO CAMERA TO THEIR BACKS
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To observe the underwater behavior of elephant seals (*Mirounga angustirostris*) at sea, we attached small (23 cm long, 12 cm diameter), underwater video cameras to the backs of two premolt, juveniles of each sex (average BM = 174 kg). The seals were captured at Año Nuevo State Beach Park, and the video cameras glued to their backs. The first seal was released from Natural Bridges State Beach in Santa Cruz and the other about three miles west of Año Nuevo Island in water 60 m deep. The video cameras were recovered when the seals returned to the capture beach in 1-7 days. The video record of each seal was 2 hrs long. The average dive duration (6.4 min ± 2.2 S.D.), surface interval (0.8 min ± 0.2 S.D.), hourly dive rate (17/hr) and stroke frequency (0.9/sec) were identical for both seals. Seals descended at a steep angle, remained at depth while swimming, then ascended at a steep angle. No foraging was observed, but jellyfish and a small sting ray were observed. Attaching miniature, low-light, underwater video cameras to the backs of pinnipeds holds great promise for observing their underwater behavior.

EIGENSHAPE ANALYSIS OF THE CETACEAN HUMERUS
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This study investigates the relationships among osteological shape change, function and phylogeny, using the cetacean humerus. This bone is highly modified from that of terrestrial mammals; its morphology is marked by loss or reduction of bony processes and muscle scars. Eigenshape analysis, an outline-based morphometric technique, is used to evaluate humeral shape change. Unlike landmark-based morphometric procedures, eigenshape analysis compares variation in homologous outline regions of the study specimens. The geometric variants of shape change in the cetacean humerus include caudal border curvature, midshaft width, development and position of the delto-pectoral crest, distal width, and shape of head. Cluster analysis generated by the eigenshape program reveals discrete humeral bauplans, generally determined at the phylogenetic level of family. Taxa from the same family will exhibit similar humeral shape despite functional variation; higher phylogenetic relationships will not be reflected by shape if functional relationships are different.

RANGE CHARACTERISTICS OF PACIFIC COAST BOTTLENOSE DOLPHINS

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A total of 241 boat-based photoidentification surveys of Pacific coast bottlenose dolphins were conducted between September 1981 and December 1989 in four discrete coastal study areas within the Southern California Bight. San Diego served as our "primary" study area (174 surveys, 404 identifications) while Santa Barbara (12 surveys, 49 identifications), Orange County (44 surveys, 133 identifications), and Ensenada, Mexico (11 surveys, 68 identifications) served as "secondary" study areas. Between 88% to 94% of the individual dolphins photographed in Santa Barbara, Orange County and Ensenada were also photographed in San Diego. Virtually all of these dolphins were sighted in the nearshore area; more than half exhibited back and forth movements between study areas; and 30% were documented to travel as far as 250 to 350 km between sightings. During 1990 eight additional surveys were carried out to the south of Ensenada in the coastal waters of San Quintín, Baja, Mexico. Only one of the 105 dolphins photographed in San Quintín has been photographed in the Southern California Bight. We interpret the data presented and reviewed above, along with the low resight data from long-term photographic studies in the San Diego area, as evidence that Pacific coast bottlenose dolphins within the Southern California Bight are a relatively isolated but highly mobile population within a narrow coastal zone.

SURVIVAL OF FIVE SPECIES OF CAPTIVE MARINE MAMMALS

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Information on 1528 bottlenose dolphins (BD), 69 killer whales (KW), 74 beluga whales (BW), 2458 California sea lions (CSL) and 46 Steller sea lions (SSL) was available from the Marine Mammal Inventory Report (MMIR) of NMFS. The number of deaths reported for each of these species was 627, 32, 29, 869, and 12. Annual rates of survival in captivity between 1988 and 1992 were 0.951, 0.937, and 0.954 for BD, KW, and BW, respectively. The survival rate of BD calves (< 1-year of age) was significantly less than the survival rate of non-calves (0.666 vs 0.944, P < 0.005), using all of the MMIR data. The annual rate of survival for CSL between 1988 and 1992 was 0.952. Survival of CSL pups (< 1-year of age) was significantly less than survival of non-pups (0.858 vs 0.945, P < 0.005), using all of the MMIR data. Survival of SSL non-pups and pups was not significantly different (0.963 vs 0.983, P> 0.25). Annual survival rates for BD and CSL significantly increased over the last five years. For non-calf BD and KW, the difference between survival rates for captive and wild (BD:Wells and Scott 1988, KW: Bigg 1982) animals was marginally significant (P = 0.07 and 0.06 for BD and KW, respectively).

THE TACTILE SENSITIVITY OF THE VIBRISSAE-SYSTEM OF HARBOR SEALS (*PHOCA VITULINA*)

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There is still a critical paucity of knowledge about the sensitivity of the vibrissae-system of pinnipeds and how these animals actually use their whiskers to obtain tactile information about objects in their environment. For this reason a psychophysical experiment was conducted to determine tactile difference thresholds of two blindfolded Harbor seals (*Phoca vitulina*).
In a two alternative forced choice procedure the tactile size-discrimination ability of one female and one male seal was tested using a modified method of constant stimuli. Fifteen perspex disks with a diameter range from 1.12 cm to 8.74 cm were used as stimuli. Relative difference thresholds (c) were determined for three different disk sizes. In accordance with Weber's law the value of the relative difference threshold remained nearly constant for all tested disk sizes. Its mean value was c = 0,17 for the female and c = 0,19 for the male seal. This tactile resolution power of the seals vibrissae-system is comparable to that of the hands of lower primates.
A frame by frame analysis of video recordings of the touch behavior revealed that the tactile discrimination depends on two sensory systems: a) the tactile sensitivity of the vibrissae and b) on kinaesthesis in form of precisely controlled head movements. The importance of both sensory systems for the discrimination of size differences will be discussed on the basis of a model.

COMPARISON OF 1983 AND 1992 EL NIÑO IMPACTS ON CALIFORNIA SEA LION AND NORTHERN FUR SEAL POPULATIONS IN CALIFORNIA

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Populations of 5,000 northern fur seals and 70,000 California sea lions breed on San Miguel Island and both populations are increasing. In southern California the 1983 El Niño began in October 1982 with increased sea level height and sea surface temperature and depressed thermoclines; it continued until late 1984. The 1992 El Niño began in January 1992 and continued through the 1992 and 1993 breeding seasons. We examine the similarities and differences in the impacts of the two events to gain understanding of how they affect fur seal and sea lion individuals and how the impacts contribute to population regulation. In the 1983 breeding season, numbers of fur seal pups born decreased by 60% but remained stable in 1992. Sea lion births declined 30% and 16% in 1983 and 1992, respectively. In 1983 pup mortality was not measured but in 1992 pup mortality was 23% for fur seals and 32% for sea lions. Pups of both species were significantly lighter at 3 months of age in both 1983 and 1992 than in other years. Juvenile and adult female fur seal mortality increased in 1983; it required 6 years for fur seal births to again reach 1982 levels. Sea lion births recovered to within 10% of 1982 levels in 1984. Pupping began late in 1993 and production (births and growth) is expected to be significantly reduced for the season.

The earlier onset of the 1983 El Niño occurred just prior to implantation for both species which may explain the greater decrease in pup production in 1983 than in 1992. Oceanographic conditions associated with El Niño cause sea lion and fur seal prey abundance and/or availability to decline, reducing the nutritional intake of individual animals. This results in decreased production and increased mortality on the population level. These recurring non-density-dependent effects increase annual variability in vital rates and reduce the long-term carrying capacity.

It is not birth, marriage or death but gastrulation which is truly the most important time of your life.
-Lewis Wolpert

DETERMINATION OF GENDER OF INDIVIDUALLY IDENTIFIED FINBACK WHALES USING POLYMERASE CHAIN REACTION.

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Individual finback whales within the Gulf of Maine were identified from characteristic pigment patterns, dorsal fin shape and scars. Sightings of 537 fin whales and associated behavioral data are catalogued in the North Atlantic Finback Whale Catalogue housed at the College of the Atlantic in Bar Harbor, Maine. Photo-identification studies of fin whales suggest a greater frequency of cow/calve pairs occurring in the southern Gulf of Maine. Few reliable methods exist for determining the sex of free ranging fin whales in the field. The gender of 40 individual fin whales, sampled in the northern or southern areas of the Gulf of Maine were determined using polymerase chain reaction amplification of the sex specific region SRY from DNA extracted from skin biopsies. 45 percent (45%) of the whales sexed contain photo-identification life histories records with multiple year sightings in the North Atlantic Finback Whale Catalogue. Life history data for those fin whales with multiple year sightings span 2 to 13 (mean 6.61) years. Combination of gender data with behavioral and sightings data provides a better understanding of fin whale social interactions and dynamics then was previously possible.

SOCIAL MATURITY AND SEASONALITY IN LONG-FINNED PILOT WHALES

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Social maturity and seasonality of males long-finned pilot whales are described, based on material collected from 39 schools of long-finned pilot whales caught by the Faroese drive fishery in the period July 1986 - December 1989, and including 297 testes and 91 blood samples from maturing and mature animals. Determination of seasonal activity is based on morphological and histological examination of testis, density of spermatozoa on epididymal smears and plasma testosterone radio-immunoassay titration. Social maturity is investigated from school composition and morphological characters.

The testicular activity is diffusely seasonal and peak between March and September. No complete standstill of testicular activity is observed and a non-negligible proportionof males is capable of reproducing outside the main breeding season. Testis weight increases 1.5 times during the period March-September. Testosterone concentrations show a bimodal pattern and increase of about 2.5 times in the period March-September minus July with a significant dip in July. The diffuse pattern of seasonality might be due, at least partly, to a non geographical homogeneity of the schools sampled.

Histological maturity is reached at an average age of 17.0 years but social maturity seems to be delayed for several years. School structure suggests that males move away from their natal school after puberty, aggregate in others or segregate, at least temporally.

TEMPORAL VARIATION IN REPRODUCTIVE ACTIVITY OF MALE ELEPHANT SEALS: EFFECTS OF BREEDING OPPORTUNITIES AND THERMOREGULATORY CONSTRAINTS

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Variation in reproductive activity of male northern elephant seals (*Mirounga angustirostris*) was examined over two time scales: (1) over the breeding season, in relation to changes in female number and reproductive condition; (2) over the diel cycle, in relation to temperature and other environmental variables. Time allocation to reproductive activities at four sites with differing numbers of breeding females, and frequency of male-inflicted injury, were measured over the course of three breeding seasons at Año Nuevo, California. One harem was observed for five 24-hr periods, using a night vision scope to record nocturnal behavior. Changes in agonistic activity, sexual activity, and frequency of male injury over the breeding season corresponded with changes in female number on the rookery, peak activity occurring at the time of maximal female abundance. Breeding activity was highly variable over the diel cycle, but generally there was a mid-day lull in activity with minor crepuscular peaks. This can be attributed to the negative correlation between agonistic and locomotory activities and temperature; sexual activity was not significantly correlated with temperature, however. Males appear to adjust their level of reproductive effort in relation to seasonal changes in potential benefits (i.e., number & accessibility of potential mates), subject to the constraints of thermoregulatory requirements.

POPULATION AND PHYLOGENETIC STUDIES OF THE SPERM WHALE USING MITOCHONDRIAL D-LOOP SEQUENCES.

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We are using sequence data from the mitochondrial D-loop region of sperm whales (*Physeter macrocephalus*) to examine population differentiation of whales within and between the Atlantic, Pacific and Indian oceans. To date, the entire D-loop has been sequenced from five individuals representing the three oceans. Nucleotide differences (in the form of insertions/deletions and transitions) have been found at 11 positions. No differences were found in the central "core" region; most changes occurred at the 3′ end of the light strand. Based on the level of variability found across the D-loop, a small portion of the 3′ end is being targeted for population studies using PCR-based sequencing.

In addition, we have examined cetacean phylogeny using the D-loop. Along with the sperm whale D-loop, we have cloned and sequenced the D-loop from the pygmy sperm and northern bottlenose whales and have aligned these to published sequences from orca, dolphin, fin, minke and an ungulate outgroup, the cow. Using neighbour joining distance methods, our preliminary analysis suggests that sperm whales diverged early in the radiation of cetacean lineages.

INTRASPECIFIC STRUCTURE OF THE NORTHERN RIGHT WHALE DOLPHIN (*LISSODELPHIS BOREALIS*): THE STATISTICAL POWER OF AN ANALYSIS OF MOLECULAR VARIATION FOR DIFFERENTIATING GENETIC STOCKS

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To obtain quantitative measures of reproductive isolation (evidence of monophyly, reduced gene flow, etc.) between population centers of the fishery-impacted northern right whale dolphin (*Lissodelphis borealis*), a portion of the control region of the mitochondrial DNA (mtDNA) genome was sequenced in 55 geographically dispersed individuals, then analyzed in an nested ANOVA format. No evidence of geographically concordant population structuring was apparent when the sample population was stratified into two offshore populations (west and east of the international dateline) and one inshore population (California coastal). In addition, a Mantel test, examining pairwise correspondence between geographic and genetic distances among samples, failed to detect any evidence of isolation by distance. A power analysis conducted to determine the probability that a comparably sized survey would yield statistically significant evidence of segregation revealed the potentially low power of mtDNA sequencing studies for detecting differences among closely related populations. This suggests caution in accepting the null hypothesis of a single, panmictic stock for the northern right whale dolphin.

INCIDENTAL TAKES OF CETACEANS IN A PHILIPPINE INDIGENOUS DRIFTNET FISHERY

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Monitoring of incidental cetacean catches in the indigenous driftnet fisheries in Siaton, Negros, Philippines began in April 1991 and continued on to May, 1993. The fishery operated in the Sulu Sea from January to June and involved the use of a 10m inboard-powered boat with outriggers, a 500-300m x 18m multi-filament net with a mesh size of 15cm and kerosene lamps floated on the surface at regular intervals to mark the position of the nets. The number of boats operating in the fishery increased from 30 in 1991 to 50 in 1992 and 1993. The major fish species caught were the yellowfin and skipjack tuna. The cetacean species incidentally caught were: the spinner, Fraser's, Risso's and spotted dolphins and the dwarf sperm and pygmy killer whales. Recorded by-catches were: 55 individuals (Apr-Jun, 1991), 162 (Jan- Jun, 1992) and 116 (Jan-Jun, 1993).

THE IWC'S *RMP* AND *RMS* - ACRONYMS, ANACHRONISMS OR A MANAGEMENT PROCEDURE FOR WHITE ELEPHANTS?

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In 1982, the International Whaling Commission (IWC) agreed to implement a 'pause' in commercial whaling from 1986. The rationale for this was that there was insufficient scientific knowledge to safely manage whale populations using the management procedure currently in place. Considerable effort was invested in developing a management procedure that relied only on information that was likely to be obtainable (this eventually narrowed down to estimates of absolute abundance and information on catch numbers) and that took into account the inevitable uncertainty in any such information. Testing was carried out using extensive computer simulation trials for all assumptions and all likely and even many unlikely scenarios.

Initially, work focussed on 'known' biological stocks. A major problem in management, is of course, determining stock identity; the procedure also had to be robust to errors in this. A complete procedure for calculating catch limits for baleen whales was defined (the *Revised Management Procedure* or *RMP*). This was 'accepted' by the Commission in 1992 but further aspects (both scientific and non-scientific) were identified that required further work as part of a *Revised Management Scheme (RMS)*. The scientific aspects of this work were completed at the 1993 meeting of the Scientific Committee and unanimously recommended to the Commission. The culmination of eight years' work was the most rigorously tested management procedure for a natural resource yet developed. It sets a standard for the management of all marine resources.

It was not adopted by the Commission.

A MANAGEMENT PLAN FOR SEA OTTERS IN ALASKA

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The return of sea otters (*Enhydra lutris*) from near extinction and the recolonization of most of their historic range in Alaska is one of the great conservation stories this century. However, this success has not been without some conflict and controversy. Upon 1988 recommendations from Congress and the Marine Mammal Commission, the Fish and Wildlife Service initiated the development of a management plan for sea otters in Alaska. Development of a long-term plan was timely given conflicts associated with increasing sea otter populations, increasing threats to sea otters from coastal development, and increased hunting pressure on sea otters.

The goals of the management plan are to maintain the sea otter population in Alaska within its optimal sustainable population range, to maintain healthy habitats for sea otters, and to allow for uses of sea otters that include harvest by Alaska Natives and viewing by the public.

The plan identifies cooperative management strategies for guiding the harvest of sea otters by Alaska Natives and resolving shellfish and tourism resource conflicts. Much of the plan implementation relies upon the development of cooperative management agreements among Native hunter organizations.

A MOBILE VIDEO/ACOUSTIC SYSTEM FOR SYNCHRONOUS RECORDING OF DOLPHIN VOCAL AND BEHAVIORAL ACTIVITIES

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Some studies of free-ranging odontocetes have successfully linked general vocal and behavioral activities for groups of individuals. Work with captive dolphins has provided invaluable insight into the vocal repertoire of species and individuals. Still, due primarily to environmental and technological constraints, little information has been collected on specific behaviors and associated vocalizations of individual free-ranging dolphins. We have developed and utilized a mobile video/acoustic array that permits real-time synchronous recording of the vocalizations and behavioral activities of individual, wild dolphins. Manually operated underwater, the system consists of two omni-directional hydrophones cabled through a custom underwater housing into a stereo Hi8 video camera. Hydrophone spacing on the housing is scaled, based upon the speed of sound in water and the human inter-aural distance. Localization of the vocalizing dolphin is based upon associating the visual distribution of animals with directions to the sound sources as determined by aural psychoacoustics. Examples of the utility and application of this system are presented for free-ranging Atlantic spotted dolphins (*Stenella frontalis*).

GENETIC ASSESSMENT OF A CAPTIVE BELUGA BREEDING GROUP: A COMPARISON OF TECHNIQUES FOR EXAMINING GENETIC VARIABILITY IN WILD BELUGA POPULATIONS

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Chromosomal and DNA analyses were performed on 14 beluga whales in Sea World's breeding program for Delphinapterus leucas. Thirteen of the whales were wild-caught and one was a calf born in this breeding colony in 1992. The wild-caught whales originated from Churchill River, Hudson Bay, Manitoba, Canada from 1976 through 1988. Paternity was confirmed using DNA fingerprinting and chromosome heteromorphism analysis. Genetic variability among the wild-caught whales was investigated with both DNA and chromosome markers. DNA fingerprints were established with Hae III, Hinf I and Alu I, using the hypervariable DNA probe PV-47-2. Average DNA fragment or band sharing among the wild-caught belugas was 39%, indicating a high degree of individual difference in DNA fingerprints within the Churchill River population. Band sharing between mother and calf was 80%. One of the wild-caught whales shared this degree of DNA similarity with three of the other wild-caught animals. Comparison with genetic patterns in bottlenose dolphin populations, suggests the existence of genetically discernible subgroupings within the population of belugas in Churchill River.

REPRODUCTIVE COMPETENCE IN 2 YEAR OLD CALIFORNIA SEA LIONS

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Following the birth of pups in a breeding facility where all male California sea lions (Zalophus californianus) three years of age and older had been previously castrated, an investigation of paternity and reproductive competence of the two year old males was undertaken. Paternity was verified by DNA fingerprinting using the hypervariable DNA probe PV-47-2. Histological evidence supported active spermatogenesis at two years of age. The age at which male California sea lions have been thought to reach reproductive maturity ranges from three to five years of age. The observations in this breeding management program indicate that successful copulation and impregnation of reproductively mature females can be achieved by "juveniles" at two years of age. For captive breeding programs, this means that to maintain zero population growth, castration or separation must take place prior to the breeding season for two year old males, as well as older males. For field studies, although reproductive success may be largely effected by male competition for females, it suggests that including the juvenile two year old males in potential breeding observations may be important.

AN ASSESSMENT OF THE STOCK IDENTITY OF SPERM WHALES IN THE EASTERN EQUATORIAL PACIFIC

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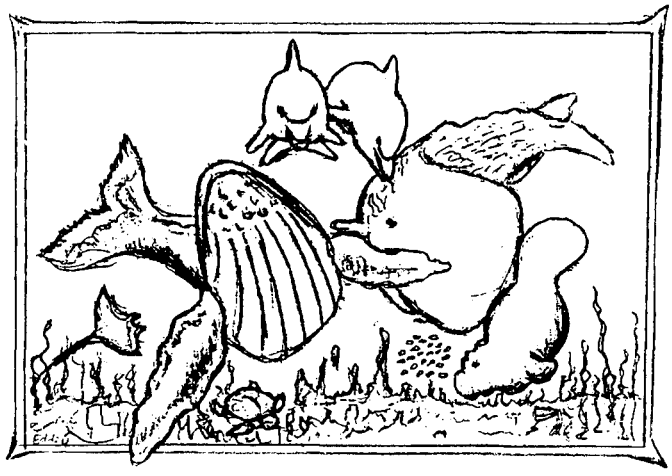
Adult female and immature sperm whales (*Physeter macrocephalus*) seen off the Galápagos Islands and near mainland Ecuador in 1991 were identified through the technique of photo-identification. These photographs were matched with existing identifications collected off the Galápagos in previous years since 1985 and off mainland Ecuador in 1985. A comparison of the frequency of the different mark types per individual from the two regions was also conducted. The results support the hypothesis that adult female and immature sperm whales seen off the Galápagos and off mainland Ecuador belong to different populations defined by the observation that they do not undergo complete mixing over a period of two years. A movement of ten whales from the Galápagos to the Ecuador region was observed. This could be explained as a possible migration from the recently unexploited Galápagos area to the recently exploited coastal area where the stock of sperm whales has been shown to have been substantially reduced.



Time is nature's way of keeping everything from happening at once.
-Anon.

PHYLOGENETIC ANALYSIS OF NORTHERN HAIR SEALS BASED ON NUCLEOTIDE SEQUENCES OF THE MITOCHONDRIAL CYTOCHROME b GENE

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Phylogenetic analysis of a 458-nucleotide sequence from the mitochondrial cytochrome b gene of eleven hair seal taxa did not support currently accepted taxonomy. A novel finding of both neighbor-joining and parsimony analyses was a sister taxon relationship between the grey seal, Halichoerus grypus, and the ringed seal, Phoca hispida. Although intraspecific genetic variation was low in most of the taxa, cytochrome b may be useful for population genetic studies of the ringed seal. The present study provides context for sequence data from seals endemic to Lake Baikal and the Caspian Sea, taxa central to questions of phocine biogeography.

HEMATOLOGICAL AND PLASMA CHEMICAL CONSTITUENT VALUES FOR CAPTIVE YOUNG, IMMATURE AND WILD BREEDING GREY SEALS

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Nineteen weaned female grey seal pups (*Halichoerus grypus*), 12 pups from Sable Island, Nova Scotia and 7 pups from the Gulf of St. Lawrence were captured in January 1992 and transported to the seal holding facilities at Dalhousie University, Halifax N.S. Blood samples were taken from a subsample of the captive population (N > 6) at ages 75, 82, 89, 96, 103, 117, 124, 138, 152, 176, 194, 202, 209, 216 days for hematological constituent values and at ages 124, 152, 194, 216 days for chemical constituent values. There were no significant differences in hematological or chemical constituent values between the sampling ages of the seals so the respective values were combined to produce overall hematological (N = 149) and chemical (N = 39) values. Blood samples were taken from wild breeding grey seal females (N=30) in January 1993 on Sable Island, N.S. to further define hematological constituent values. These overall constituent values should provide a more complete and precise baseline for veterinary diagnosis of sick and injured seals.

THERMAL BIOGEOGRAPHY: THE COMPLEMENTARY DISTRIBUTION OF MARINE MAMMALS AND LARGE FISHES

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Most species, and by far the greatest biomass, of marine mammals feed in temperate or polar regions. The primary hypothesis to account for this distribution has been that standing stocks of food of sufficiently high density to support marine mammals only exist in high latitude areas of upwelling and convergence. The distribution of large pelagic fishes is in marked contrast to that of marine mammals. Although large fishes are found in all tropical and sub-tropical seas, there are virtually none exploiting the rich resources found at high latitudes. To date, no explanation has been offered to account for this phenomenon. A related question concerns the evolution and radiation of marine mammals. Presumably, at the time when the ancestors of the pinnipeds and cetaceans were invading the seas, existing fishes would have been better adapted to an aquatic existence than would have terrestrial mammals. Unless some constraint precluded fishes from fully exploiting available resources, it is hard to imagine there being a niche available for the mammals. The striking complementarity of the distributions of large marine ectotherms and endotherms suggests this constraint is (was) energetic. We propose a model in which rates of digestion, assimilation, metabolism, and growth are strongly temperature dependent. At low temperatures pelagic marine ectotherms of large size either cannot survive or grow at inordinately slow rates. Conversely, the profligate energy expenditure of endothermic homeotherms limits their ability to exploit the low resource levels characteristic of warm environments. Temperature is also shown to affect the trophic structure of marine communities. Fundamental differences in the biomass available for exploitation by high trophic level consumers exist between warm and cold marine environments despite comparable levels of primary production. We offer paleontologic and biogeographic evidence to provide support for the models presented. We also consider the implications of thermal regimes for the evolution of large marine reptiles and endothermic fishes.

THE MARINE MAMMAL PROTECTION ACT IN 1993: REPLACING THE INTERIM EXEMPTION FOR COMMERCIAL FISHING

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In 1988, Congress amended the Marine Mammal Protection Act (MMPA) to allow commercial fishing operations a temporary exemption to the moratorium on taking marine mammals. The interim exemption expires 30 September 1993. In December 1992, the National Marine Fisheries Service submitted its propose management regime to Congress. That proposal maintained the MMPA philosophical approach that taking marine mammals was prohibited unless such takes could be authorized without preventing a population's recovery to, or maintenance within, its Optimum Sustainable Population limits.

Representatives from some environmental groups and the fishing industry negotiated another proposal, which was submitted to Congress in early June 1993. The negotiated proposal contained a general authorization to take marine mammals including those population stocks with unknown or depleted status. A number of environmental groups with representatives on the negotiating team refused to sign the negotiated proposal and submitted criticism of specific portions of the proposal to Congress in late June 1993.

Congress should act on these proposals by 30 September 1993. In this presentation, I will describe the major elements of each proposal and resulting legislation passed by Congress.

SIGHTABILITY OF RIGHT WHALES BASED ON DIVE AND RESPIRATION PATTERNS OBSERVED FROM A BLIMP.

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Aerial surveys are one of the main methods for estimating whale abundance and distribution. The probability that a whale is at the surface when a survey aircraft passes overhead is dependent on the proportion of time the whale spends at the surface. Whales' dive and respiration patterns vary with species, age, behavioral mode, and geographical location.

In 1992, we studied right whales on their coastal wintering grounds off the southeast United States, using an airship (blimp) as a research platform. The airship offers the same aerial vantage point as an airplane, but the slow hovering speed allows for the collection of fine-scale behavioral data. Respiration data and dive times were extracted from video and audio recordings made during a total of 12 hours stationed near 14 individual right whales.

In addition to providing baseline data on dive times and respiration, this preliminary study showed that, in the southeast, different social categories have distinctly different sightability. Mother/calf pairs were at the surface 75% of the time; surface-active groups 69%; and lone juveniles 32%.

Existing demographics for the southeast between 1980 and 1991 show twice as many mother/calf pairs as juveniles. Since our data indicate the chances of seeing a mother/calf pair are more than twice those of sighting a lone juvenile, one might ask whether these demographics are a true reflection of the seasonal distribution, or more a reflection of skewed sighting probabilities.

EPIZOOTIOLOGY OF MARINE MAMMAL MORBILLIVIRUSES IN THE WESTERN NORTH ATLANTIC

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Recent epizootics among pinnipeds and odontocetes in Europe have established morbilliviruses as the most potent viral pathogens of marine mammals. An extensive retrospective epizoological study was carried out to determine the prevalence and significance of morbilliviruses in the western North Atlantic. Serum and formalin-fixed tissue samples were obtained from seven pinniped and seven odontocete species covering a geographic range from Arctic Canada to the Gulf of Mexico. Samples were collected between 1983 and 1993 from both free-ranging and stranded animals. Sera were tested by the virus neutralization test (VNT) against a panel of five morbilliviruses. Tissues were processed by standard procedures and also, where necessary, immunohistochemistry using monoclonal antibodies against phocine distemper virus (PDV) H protein. Overall, 19.7% (82/416) of the phocids (harbor, grey, harp and hooded seals), and all of the walruses (3/3), were sero-positive (i.e., $\log_2$ VNT titer ≥ 3) against PDV. Among the morbilliviruses, the percentage of sero-positive sera and their corresponding VNT titers were highest against PDV than the other morbilliviruses. The first positive samples were collected in 1986 confirming that PDV has been an endemic infection in the western Atlantic at least since this time. Phocine distemper pneumonia and encephalitis was also confirmed as a sporadic cause of mortality among juvenile harp and harbor seals. Neutralizing antibody titers were detected in 27% of bottlenose dolphins (4/15) from the east coast of the United States but there was no evidence of clinical disease in any of the cetacean species. Differential VNT indicate that different morbilliviruses may be circulating in pinniped and cetacean populations.

PINNIPED STRANDINGS ALONG THE CALIFORNIA COAST (1982-1992)

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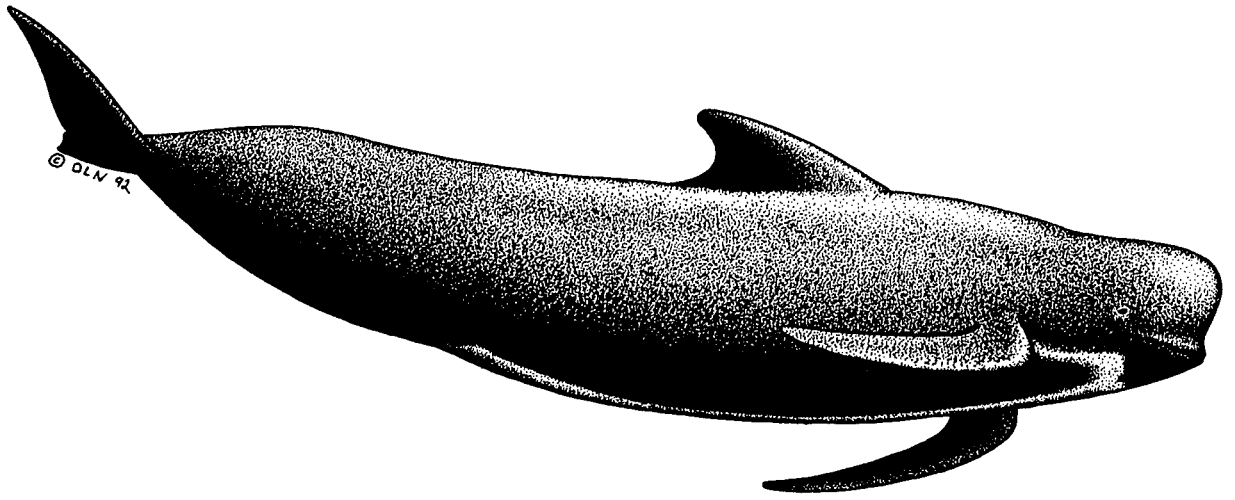
I analyzed records of California sea lion (*Zalpohus californianus*) and northern elephant seal (*Mirounga angustirostris*) strandings along the California coast from 1982 through 1992. Data consisted of live and dead animal strandings collected by different stranding agencies throughout California and consolidated by National Marine Fisheries. Strandings of each species increased steadily during the 11 year period, coincident with increases in the abundance of each species on the Channel Island Rookeries. Strandings in 1983-84 and 1991-1992 were exceptionally high and evidently related to poor foraging conditions caused by warm water intrusions into California during the El Niño events in those years. In other years most stranded animals were in poor physical condition. The major cause of stranding appeared to be related to poor foraging success of individuals, complicated by disease. Increases in strandings were primarily associated with increased populations and periodic environmental disturbances.



INTERLEUKIN-2 RECEPTOR EXPRESSION ASSAY: A NOVEL METHOD FOR MEASURING IMMUNOCOMPETENCE

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We have developed a novel assay for use in evaluating the immune system of dolphins. Mitogen-induced proliferation, currently the method used in assessing the functional capacity of lymphocytes, is a measure of a cell population's proliferation response. Because lymphocytes do not all have the same proliferative capacity, proliferation assays are unable to give a complete picture of immunocompetence. Interleukin-2 receptor (IL-2R) expression is increased on activated T-lymphocytes. Measuring the expression of IL-2R, then, is a method of determining the activation capacity of lymphocytes, independent of their ability to proliferate. By stimulating lymphocytes with mitogen and assaying for the expression of IL-2R, we are able to examine individual cells for their activation response.

We have performed both proliferation and IL-2R expression assays on dolphins from different populations. We have determined the optimum mitogen concentration to be 0.1 µg/ml ConA and PHA. IL-2R expression reaches a maximum at 36 hours in culture. Receptor expression is assessed using phycoerythrin-conjugated recombinant human IL-2 and flow cytometry. In most cases, proliferation and IL-2R expression correlated well: populations with increased proliferation also exhibited increased receptor expression, as expected. However, in some cases, cell populations that had decreased proliferation showed increased receptor expression and vice versa. This indicates that proliferation and IL-2R expression assays measure similar but distinct parameters of lymphocyte activation. Both assays are important in evaluating the immune system of dolphins.

IDENTIFICATION AND PARTIAL CHARACTERISATION OF PHOCID INTERLEUKIN-1 (IL-1) AND INTERLEUKIN-6 (IL-6) BIOACTIVITIES.

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There has been much speculation about the possible immunosuppressive effects of xenobiotic pollutants in seals. To investigate this hypothesis, reagents and assays specific for the seal immune system are required. We have selected for initial characterisation studies two macrophage derived cytokines (IL-1 and IL-6) with important pivotal functions in the regulation of inflammatory and immune responses.

Leucocytes were separated from heparinized seal blood by discontinuous density centrifugation. After culture with lipopolysaccaride (0-10 µg/ml), cell free supernatants were bio-assayed for IL-1-like and IL-6-like activity using the murine D10 and B9 cell lines respectively. Molecular weight determination by bioassay of Superose 6 gel fractions produced values of 17 kDa for IL-1 and a range of 17-25 kDa for IL-6. Confirmation of assay specificity was achieved by inhibiting the D10 assay with human IL-1 receptor antagonist and by neutralising seal leucocyte IL-6 activity in the B9 assay with polyclonal goat and rabbit anti human IL-6 serum. Significantly elevated plasma IL-6 concentrations (compared with 'normal' pups) were detected in pups with evidence of systemic infection or fever.

The D10 and B9 assays allow reliable measurment of IL-1 and IL-6 production by seal leucocytes and should facilitate the investigation of the effects of xenobiotics on immune function in these animals. Measurement of IL-6 using the B9 assay may also have general application as a marker of inflammation.

CHARACTERISTICS OF THE POLAR BEAR HARVEST BY ALASKAN NATIVES, 1961-1992.

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Under the Marine Mammal Protection Act (1972) polar bears may be harvested for subsistence purposes or creating handicrafts by coastal dwelling Natives, provided the take is not wasteful and the population not depleted. The majority of polar bears taken are by Alaskan Natives. The peak harvest period is from November to May (87.7%), when the pack ice is near the shoreline. The average annual harvest of polar bears declined from 260 to 121 animals during the periods 1960-1972 and 1980-1992, respectively. Approximately 75 percent of the bears harvested from 1960-1972, were males. In contrast, the sex ratio of harvested bears from 1980-1992 was 66:34, males to females. Data from telemetry and carbon isotope analysis suggest that population stocks occur in the Beaufort and Chukchi seas, respectively. Approximately 70 percent of the bears taken state-wide come from the Chukchi population which extends into the northern Bering Sea during winter. Although the annual sex ratios (1980-1992) were more variable in the Beaufort Sea population they were not significantly different from those in the Chukchi Sea population. The harvest was comprised of the following age classes: 47 percent adult, 27 percent subadult, and 26 percent dependent cubs. Efforts to resume hunting in eastern Russia, if successful, could affect the Native subsistence harvest of this shared population.

IS POLLOCK JUNK FOOD? MAINTENANCE REQUIREMENTS AND ASSIMILATION EFFICIENCIES OF CALIFORNIA SEA LIONS FED POLLOCK AND HERRING

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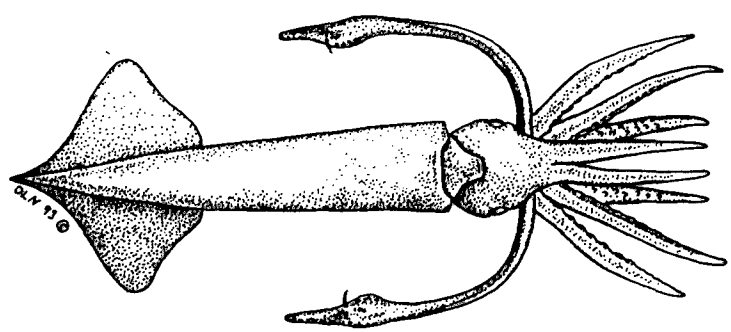
Steller sea lions have been decreasing in abundance throughout the Bering Sea and Gulf of Alaska. One proposed cause was related to a possible change in their nutritional status, following a diet shift from relatively high-fat fishes to feeding on relatively low-fat pollock. However, enough data on the nutritional requirements of Steller sea lions does not exist to properly evaluate this idea. We measured maintenance metabolism and assimilation efficiencies (AE%) of captive California sea lions fed diets of pollock and herring. Two sea lions (59 and 112 kg) were alternately fed diets of Atlantic herring or walleye pollock until body mass was stable within 0.5 kg during 3 separate trials. After at least 3 d on the diet, fecal samples were collected. Proximate composition of fish, and manganese content of fish and feces were determined to ascertain AE%. Pollock were 79% water and 2.5% lipid, while herring were 75% water and approximately 8% lipid. Sea lions maintained body mass on intakes of 0.077±0.003 and 0.103±0.005 kg/d/kg herring, and 0.091±0.04 and 0.145±0.02 kg/d/kg pollock. This 1.3 fold increase in intake was less than expected based on prey caloric content. Continuing laboratory analyses of the AE% will provide an indication of the relative "quality" of the two diets.



THE IMPROVED PERMIT PROCESS - HOW IT WILL WORK

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A major evaluation of the National Marine Fisheries Service marine mammal permit program was conducted to identify regulations and policies in need of revision to streamline the permit process, establish clear and consistent permit criteria, and be more responsive to applicants. Public input during 7 working sessions and numerous letters on the subject were used to identify areas of the program in greatest need of improvement. A proposed rule revising existing regulations on permits for scientific research and public display is expected to be published for public comment by the fall. We will outline the proposed regulations, highlighting areas most applicable to the scientific research community. Proposed definitions and standards applicable to requirements of the Marine Mammal Protection Act and the Endangered Species Act will be presented. Particulars of the existing research permit process will be summarized for comparison with proposed revisions.

COMPARATIVE MYOLOGY OF THE LIVING FOSSIL, MONACHUS SCHAUINSLANDI

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Comparison of the musculature of the Hawaiian monk seal with that of other pinnipeds and terrestrial carnivores disclosed an array of features consistent with its description as a "living fossil" and with the theory of monophyly of the Pinnipedia. Overall, the musculature is most similar to that of the other phocids, but it shows several plesiomorphies shared with terrestrial carnivores, as well as with the otariids. Some examples of the latter in the forelimb musculature include 1) an m. trapezius complex more similar to those of the otariids and terrestrial carnivores than to the other phocids and the walrus, 2) co-insertion of the m. pectorales, m. teres major, and m. latissimus dorsi onto a tendinous bicipital arch, closely resembling that in Felis, and 3) an m. deltoideus in two distinct parts, more similar to those of the terrestrial carnivores than to those of the other pinnipeds. All pinnipeds are synapomorphic in their possession of the basic "flight" musculature essential for forelimb propulsion in the water, yet only the otariids and M. schauinslandi still use it in that mode. The Hawaiian monk seal propels itself through the water with both the fore and the hind limbs, concurrently, to a degree unlike that in any other living pinniped and comparable with that described for Enaliarctos mealsi, one of the oldest known fossil pinnipeds.

DETERMINANTS OF POST-PARTUM PARENTAL INVESTMENT BY SOUTHERN ELEPHANT SEALS, *MIROUNGA LEONINA*, AT SOUTH GEORGIA.

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A detailed study of 151 mother/pup pairs of southern elephant seals (SES) over four breeding seasons has provided sufficient information to clearly demonstrate the pattern of parental investment and its underlying correlates. The only feature of parental investment which depends on the sex of the offspring is the size of the pup at birth; male SES pups are born about 5.5 kg larger than females, irrespective of the size of their mothers. The mothers of male pups are larger on average than those of female pups because small females tend to have female pups. After birth, the amount invested in offspring depends only on the mother's size or condition and the rate at which the pup takes milk, not on its sex. Large pups grow faster and larger mothers nurse their pups longer, regardless of the sex of the pup.

Mothers thus invest an amount determined by the reserves they have brought to the breeding beach and what the pup demands. They do not invest differentially in male and female offspring as has been suggested by theory. Any differences in size at weaning between the sexes are the indirect result of fetal demands or investment made by the mother prior to birth. Because of the size range exhibited by SES, apparently conflicting results on differential investment are likely if the size distribution of females is not taken into account.

THE EFFECTS OF EL NIÑO ON ABUNDANCE AND DISTRIBUTION OF COASTAL BOTTLENOSE DOLPHINS IN MONTEREY BAY, CALIFORNIA.

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Between July 1991 and December 1992, abundance of Pacific coastal bottlenose dolphin(Tursiops truncatus gilli) in Monterey Bay, California was determined using photo-identification techniques and field estimates. Throughout the study, a minimum of 2 and a maximum of 45 dolphins were sighted ($\bar{X}$=17±9). Most sightings occurred in the northern leg of the study area, between Moss Landing and Santa Cruz. The graphical comparison of population estimates before and during the 1992-93 El Niño event revealed an apparent increase in abundance during El Niño, but the mean difference (12±4 dolphins before, and 16±7 after El Niño) was not statistically significant (Mann-Whitney U). Number of identifications remained unchanged (22 dolphins) throughout 1991 up to March 1992, and rose sharply at the onset of El Niño, to reach 60 individuals by December 1992. Preliminary data for summer 1993 support the idea that population after El Niño returned to pre-El Niño levels.

Approximately 15 individuals may be permanent residents of Monterey Bay. They were consistently photographed throughout the study (October 1990 - July 1993) suggesting a stable population, exhibiting high fidelity to Monterey Bay and vicinity. This observation is in contrast with patterns observed in Southern California, with special reference to San Diego and surroundings, where bottlenose dolphin concentration is higher, but specific individuals are generally transient (Defran and Weller 1989). The significance of this discrepancy is currently unknown, but it is relevant since sixty-two percent of the animals photo-identified in Monterey Bay were previously photographed in the Southern California Bight. Pacific coastal bottlenose dolphins in California undoubtedly belong to the same population, and patterns of distribution along the coast are still to be determined. The individuals residing in Monterey Bay may have moved to this area during 1982-83 El Niño (Wells et al. 1990, Defran et al. 1991, Scott et al. 1993). Numerous sightings as well as three strandings were reported north of Monterey Bay. These sightings occurred for the first time in 1982, during El Niño, and then, again, in 1989, at a rate of 5 to 6 per year (Szcepaniack pers. comm.) One report came from as far north as San Francisco, suggesting a range extension well beyond that hypothesized by Wells et al. (1990). It is possible that El Niño events play a significant role in the distribution of bottlenose dolphins along the Pacific coast.

VOCALIZATIONS IN A JUVENILE FEMALE GUADALUPE FUR SEAL

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The vocalizations of a captive juvenile female Guadalupe fur seal (*Arctocephalus townsendi*) were examined as part of a broader behaviour study. Little is known about communication in this species, particularly in regard to females and/or juveniles. Eight common vocalizations were described: BARK, BAWL, COUGH, GROWL, PUFF, ROAR, WHIMPER, and YELP. The frequency of vocalization ranged from 0.6-15.7 calls per observation hour (mean= 4.8 voc/hr); of these, ROAR and GROWL were the most common (n= 1085 and 97 respectively). There was a daily pattern to the frequency of vocalization, which corresponded to the rehabilitation feeding schedule. Social interaction was an important factor on vocalization, especially in the context of agonism. From this study, it is obvious that females of this species have a rich and varied vocal repertoire, which matches that described for adult males.

AN ECOLOGICAL STUDY OF THE PACIFIC BOTTLENOSE DOLPHIN Tursiops truncatus IN THE GULF OF GUAYAQUIL, ECUADOR

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Between February 1990 and January 1991, 110 boat surveys were made in the inner estuary of the Gulf of Guayaquil, Ecuador (2°45´S, 79°55´W) to study the ecology of the coastal bottlenose dolphin Tursiops truncatus. A total of 849 hr were spent at sea, including 207 with the animals. Photographing naturally marked animals resulted in the recognition of 432 different dolphins.

Dolphins schools were found almost always less than 100 m from shore and moving slowly (mean 4.06 km/hr). The group size (mean= 16.02, s.d.=15.7, n=185) showed significant seasonal variation ($P<0.01$), forming bigger groups during the dry and cold season from June-November (mean=19.3, s.d.=16.5) than during the rainy and warm season from December-May (mean=12.9, s.d.=14.05). A similar seasonal variation was found in abundance. Dolphins were 4 times more abundant from June-November ($P<0.05$). Both group size and dolphin abundance are probably food related, due to the presence of small schooling fish in the inner estuary during the cold and dry season.

Resightings of naturally marked animals were used to estimate the population size, which was estimated to be 414 dolphins in 1990 and 535 in 1991. During the two years the mean density of dolphins was estimated at 0.66 dolphins/km^2. Newborn calves of 36 identified females were registered all year round without a clear seasonal tendency.

MULTIVARIATE ANALYSIS OF ENVIRONMENTAL PROCESSES THAT CUE THE MIGRATION OF THE GRAY WHALE (*ESCHRICHTIUS ROBUSTUS*)

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I am conducting a study of the initiation of the southward migration of the gray whale (*Eschrichtius robustus*). My objective is to determine the correlation between environmental processes in the Beaufort, Bering and Chuckchi Seas and the initiation of the gray whales' southward migration. Environmental factors have been linked to the migratory process of other species. The gray whale is variable in its annual migratory timing, suggesting its migration is triggered by dynamic environmental parameters. One process exhibiting annual variation in the northern feeding grounds of *E. robustus* is annual encroachment of ice which renders an area unavailable to gray whales.

My hypothesis is that ice development in the northern feeding areas triggers the migration of *E. robustus*. To test this hypothesis, I am conducting a statistical analysis that will correlate the timing of gray whale migration to two environmental parameters occurring in the Beaufort, Bering and Chuckchi Seas - ice movements and ambient air temperature. Bi-weekly ice movement data from 1972-80 and 1984-87 collected by Navy - NOAA Joint Ice Center will be the main data used in the analysis. Air temperature data are from NASA's Arctic Buoy Data. Photoperiod data will be incorporated as a check of its significance in migratory timing of *E. robustus*.

My study uses censusing data of *E. robustus* that has been collected annually at Monterey, California. Timing of migration for a given year will be determined by comparing the a year's peak passage date of whales past shore censusing stations and average swimming speeds of whales. The distribution around the mean will also be used to correlate regional ice pattern variations with migratory behavior. Estimates of annual timing of the whale migration can then be compared using multiple regression and coefficient of multiple correlation statistical analyses, with different environmental variables for corresponding years.

GROWTH AND REPRODUCTION OF NORTHERN RIGHT WHALE DOLPHIN, LISSODELPHIS BOREALIS

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Samples were obtained from 229 northern right whale dolphin Lissodelphis borealis (99 males and 130 females) taken in Japanese squid drift-nets in the central North Pacific Ocean, May-November 1990 and 1991. Ages were determined by counting dentinal growth layer groups. Female reproductive status was determined by macroscopic examination of ovaries; 67 females were mature. Sixteen percent were pregnant, 3% were pregnant and lactating, 33% were postpartum, 24% were lactating (no recent pregnancy), 10% were resting and 14% were unknown. Testes and epididymes were examined for evidence of spermatogenesis; 28 males were mature. Length at birth was calculated three ways using alternative methods resulting in estimates of 99.7 cm, 100.6 cm and 103.8 cm. Gestation period was 12.1-12.3 months. The sex ratio at birth was not significantly different from 1.0; the male component decreased with age. Average ages and lengths at sexual maturity were calculated two ways. Estimates of male average age of sexual maturity were 9.9 years and 10.1 years; average length at sexual maturity was estimated at 215.1 cm and 214.7 cm. Mature testes weights were 117.4-1300 g. Estimates of female average age of sexual maturity were 9.7 years and 10.4 years; average length of sexual maturity was estimated at 201.1 cm and 199.8 cm. Males reach an estimated asymptotic length of 265 cm, females 210 cm. Ovulation rates were < 1.0/year. Calving appeared to peak in July and August; minimum calving interval was 2 years.

OCCURRENCE AND BEHAVIOR OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN ASSOCIATION WITH THE SHRIMP FISHERY IN GALVESTON BAY, TEXAS.

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From 1990-1992, I examined the occurrence of bottlenose dolphins (*Tursiops truncatus*) in the 6.8 km long Galveston Ship Channel, an area heavily fished by bait shrimpers and bordered by an active seaport facility. I photo-identified 240 individuals, of which 75% were resighted. Twenty-three percent (n=56) of the resights were seen in each of the three years; some of them have been seen as early as 1986. Twenty-seven of the 240 dolphins were sexed as females (20 of which had calves) and two as males.

The largest groups were socializing dolphins, the smallest were feeding behind shrimp boats (4.2±2.06, 2.7±1.78, respectively). Lone individuals were often seen feeding behind shrimp boats (28%). Seventy-four percent of the IDed dolphins were seen in association with shrimp boats. Dolphins never sighted with shrimp boats were infrequent visitors (<4 sightings) to the study area. Dolphins did not alter their movements in response to the different stages of shrimp boat operation.

The large percentage (27%) of mother/calf pair sightings may indicate a strategy by some females to deal with the burden of motherhood. Mothers may prefer this area because of the easy food source, possible minimized predation risks, and reduced exposure to more turbulent sea conditions outside the sheltered channel. Dolphins could, however, be seriously impacted by boat traffic, fishing activities, and pollution in this area.

DIVE PATTERNS AND FEEDING HABITAT OF THE BOWHEAD WHALE IN BAFFIN BAY

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In conjunction with theodolite-based observations, VHF radio tags were used in 1992 to supplement a long-term study of the feeding ecology of eastern arctic bowhead whales at Isabella Bay, Baffin Island. Most feeding activity observed over 8 years involved 'fluke-out' dives of long duration highly concentrated over offshore troughs > 200 m deep. Surfacings involved stereotypic behaviour (e.g. pre-dive flexes) and frequent defecation. Faecal analysis indicated that the whales fed on mature calanoid copepods. Mature stages of C. hyperboreus and C. glacialis were found in highest densities at depths > 100 m in troughs. Five large adolescent bowheads were radio-tracked for periods of 1-23 days in 1992. Intensive feeding activity was initiated in early September characterized mainly by long dives averaging 22.3 min (sd = 5.3, n = 452; max. 41 min). These feeding dives occurred almost continuously as the season progressed. Percent time spent at the surface between long dives varied from 13 to 21%. Earlier in the season, similar long-duration dives (indicating feeding) were recorded mostly at night, whereas most whales socialized or rested over a shallow bank during daylight. These activity patterns tended to be synchronous among individuals at any given time. Productive feeding habitat is a localized, quasi-permanent feature of the arctic marine ecosystem, created by a complex of biophysical mechanisms, including seasonal migrations of copepods, and interaction of the prevailing current with submerged Quaternary fiords. Numbers of whales and feeding activity were much reduced in 'El Niño' years, 1983 and 1992.

PHOTO-IDENTIFICATION TECHNIQUES APPLIED TO THE MARINE TUCUXI DOLPHIN *Sotalia fluviatilis* AT THE BAÍA NORTE DE SANTA CATARINA, SOUTH-BRAZIL.

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A regularly-occurring group of the marine tucuxi dolphin *Sotalia fluviatilis* has been studied since March 1991 at the Baía Norte de Santa Catarina, South-Brazil, the southern limit of the species distribution. As a part of a long-term research on the ecology and behavior of the tucuxi at Baía Norte, systematic boat surveys were made for conducting studies on movements, behavior and photo-identification from 18 May to 21 June 1993. The average group size was 50 dolphins and I was able to follow them up to 8 hours per day, totaling 57 hrs of direct observations in 8 days of surveys. A total of 479 black and white photographs and 108 slides were taken. Thirteen individuals were identified trough marks, scars and nicks on the dorsal fin and on the back. Three dolphins were identified just once and the other 10 were resighted from 1 to 4 days. All identifications and resightings were obtained at Enseada dos Currais and adjacent waters. The Enseada is an approximately 4km^2 inlet where tucuxis have been observed on a daily basis (from 1 to 7 hrs/day) in feeding, socializing, mating and resting activities.

This research revealed the importance of photo-identification to the study and conservation of the tucuxi. In addition, it suggests the occurrence of a stable,resident group of tucuxis which uses the Enseada dos Currais and adjacent waters for its daily activities.

COMPOSITION OF GUADALUPE FUR SEAL MILK, Arctocephalus townsendi; COMPARISON OF ANALYTICAL METHODS.

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Little is known about the attendance behavior, lactation or milk composition of the Guadalupe fur seal females (Arctocephalus townsendi). Here we report the attendance behavior and gross milk composition of 15 females obtained during the 1992 breeding season on Guadalupe island. Females attend their neonates for 7-8 days after parturition and thereafter alternate between foraging trips lasting 5-24 days (mean 8.83 ± 6.14 SD), and lactation ashore lasting 2-4 days (mean 2.75 ± 0.86). This pattern continues for 8-9 months. Seven milk samples of females (with pups from 1-35 days old) were obtained during summer of 1992. Water and fat content were determined gravimetrically by lyophilization and ether extraction, respectively. Protein content was estimated by Kjeldahl, Bicinchoninic Acid (BCA) and gravimetric techniques. The latter estimate is the mass remaining after lyophilization and ether extraction of whole milk. The samples contained on average (± SD) 41.06 ± 2.64% fat, 42.69 ± 2.29% water. Protein content was 9.30 ± 2.27%, 14.7 ± 1.49% and 15.69 ± 1.82% by Kjeldahl, BCA and gravimetric method, respectively. Discrepancies with respect to protein content arise when analytical methods are compared. However, the composition of this milk falls within the range reported for other fur seals. The duration of the feeding trips during 1992 El Niño is longer than the reported for other species of fur seals under similar conditions.

COMPARATIVE KINEMATICS AND HYDRODYNAMICS OF ODONTOCETES

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Swimming performance was compared for odontocete cetaceans, *Tursiops truncatus, Pseudorca crassidens, Orcinus orca,* and *Delphinapterus leucas,* which display different morphologies. Propulsive motions were videotaped as animals swam steadily in a large pool. Videotapes were digitally analyzed with a computerized motion analysis system. Animals swam at relative velocities ranging from 0.4 to 2.4 body lengths/s. Stroke amplitude of the flukes decreased linearly with velocity for *Delphinapterus,* but amplitude remained constant for the other species. Tail-beat frequencies were similar among species at low velocities, but increased faster for the smaller *Tursiops* above one body length/s. Over equivalent velocities, *Pseudorca* had the greatest maximum fluke angle of attack, while *Delphinapterus* exhibited the lowest. Unsteady wing theory was used with prediction equations based on kinematics to calculate thrust, drag coefficient, and efficiency. Compared to the other species, *Orcinus* generated the largest thrust force for its body size. Minimum drag coefficients were associated with high swimming speeds and were 2-3 times theoretical turbulent drag coefficients. With its high aspect ratio flukes, *Pseudorca* had a maximum propulsive efficiency of 0.87. Lower maximum efficiencies were computed for the other animals. Maximum efficiencies for all species corresponded with velocities in the range of typical cruising speeds. The results indicate that the kinematics of the propulsive flukes and hydrodynamics correspond to the swimming behaviors and morphological designs exhibited by the whales in this study.

SATELLITE TRACKING OF HOODED SEALS (*CYSTOPHORA CRISTATA*) IN THE GREENLAND AND NORWEGIAN SEAS.

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The whereabouts and diet of the large stock of hooded seals that breed on the sea ice off the east coast of Greenland are largely unknown. In an attempt to resolve these questions, 15 mature hooded seals (10 F, 5 M) were tagged with Wildlife Computers SLTDR (0.5 or 1 W) or Telonics ST-6 satellite transmitters on the sea ice north-west of Jan Mayen (72-73°N, 10-15°W) in the Greenland Sea, in July 1992. The transmitters supplied location, dive depth and dive duration data for between 74 and 332 days (mean longevity±SD: 223±61 days). Altogether, 8770 locations were determined for the 15 seals, which corresponds to 2.62 locations per day, on average. Location data were primarily of location class 0 (77%), locations of class 1 or better being, with few exceptions, obtained from hauled-out seals only. Data show that all but one of the seals (which travelled to areas off the north coast of Svalbard, at 81°N, 15°E) stayed near the ice edge off the east coast of Greenland for long periods of the year. On one or several occasions, some of the seals left this area for excursions of 3-6 weeks duration, either to the Norwegian Sea near the Faeroe Islands, about 650 nautical miles (nm) from the ice edge (7 seals), or to the continental shelf edge (CSE) 100-200 nm south-west of Bear Island, about 450 nm from the ice edge (3 seals). The remaining 4 animals remained close to the ice edge throughout the tracking period. During excursions into open sea, the seals were diving intensively near the CSE, sometimes for 25-52 min and to depths of more than 1,000 m. A total of 36,267 hours worth of diving depth and duration data have been collected from 12 hooded seals, both in open sea and in the sea ice. Diving depth data will be correlated with fisheries survey data in order to determine which types of prey hooded seals may eat at different times of the year and in different geographical locations.

OBSERVATIONS OF ODONTOCETES DURING AERIAL SURVEYS IN HAWAII: 1993.

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Twenty-four species of cetaceans have been identified in Hawaii, but fewer than a dozen may be considered seasonal or year-round residents. Except for humpback whales and spinner dolphins, there has been little systematic study of the diversity and distribution of cetaceans in Hawaii.

Aerial surveys were flown around the main Hawaiian Islands in February and March, 1993 as part of a three year study to document the winter-time occurrence of cetaceans. The study area included near shore waters of all inhabited islands, and deep water out to seven miles beyond the 1000-fathom contour. A single engine Cessna flew pre-determined flight paths with random starting points and systematic north-south transects. A radar altimeter and GPS linked to a laptop computer allowed precise determination of location and altitude during each flight.

Total survey distance across all flights exceeded 7,000 nautical miles. An estimated 1075 animals were observed in 61 sightings. Positive identification of species was made in 47 cases (77%). These included *Stenella spp.* (esp. *longirostris* , 16 sightings), *Globicephala malaena* (13 sightings), *Pseudorca crassidens* (8 sightings), *Tursiops gilli* (5 sightings), *Ziphiid sp.* (3 sightings), *Physeter macrocephalus* and *Kogia breviceps* (one sighting). Odontocete sightings were most frequent beyond 100 fathoms and in leeward areas. *Glopbicephala malaena* was concentrated near Kauai, and *Stenella spp.* favored the southern end of the study area. This effort represents the first extensive systematic study of odontocete diversity and distribution in Hawaiian waters.

HOMING BEHAVIOR IN SUB-ADULT MALE NORTHERN FUR SEALS

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A rigorous statistical analysis of the ontogeny and other aspects of homing behavior in sub-adult male northern fur seals (*Callorhinus ursinus*) is presented. Analyses were based on 2,019 recaptures of 2- through 5-year-old males tagged as pups on their natal rookeries. Seals were recaptured on 5 geographically distinct rookery groups on St. Paul Island, Alaska, during July and early August, 1989-1992. The proportion (H) of males hauled out at their natal rookery group was investigated using log-likelihood ratio tests and logistic regression analysis.

All age groups showed a preference for their natal rookery ($p << 0.001$). Homing tendency was equal for 2- and 3-year-olds ($H = 0.50$ and 0.48, respectively), but increased significantly among 4- and 5-year-olds ($H = 0.65$ and 0.73, respectively, $p < 0.001$). Within age classes, body mass was unrelated to homing tendency. Only among 4-year-olds did homing tendency at first capture increase significantly with calendar date ($p < 0.001$). Among seals captured more than once during a season, homing tendency was significantly higher at the second and third captures compared with the first, after accounting for age and date ($p < 0.001$).

These results confirm the existence of a strong homing instinct among sub-adult male fur seals which increases with age. Also, males show less site preference when they first arrive on the island in any given year, then gravitate toward their natal rookery.

VARIATION IN UNIT STRUCTURE OF HUMPBACK WHALE SONG

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Humpback whale singers were recorded in Hawai'i during 1989 with a three-element hydrophone array. Array recordings allowed individual singers to be acoustically located. A 1-week block of recordings of songs from whales was sampled. Units from whale song were sampled if the singer was <8 km from shore or the signal/noise ratio was > 20 dB. Six different units from three themes were each sampled 4 times from 4 consecutive songs. The digitized spectrograms of these song units were cross-correlated to produce a similarity index. Samples from one whale were correlated against themselves to produce the within-whale similarity index. All combinations of whales were then correlated against each other to produce the between-whales similarity indices. The mean similarity indices for within-whales and between-whales were compared. Preliminary results indicate that similarity indices were significantly greater for within whale than between whale comparisons, although some individual between-whale indices equaled within-whale indices. This indicates that the song of one whale can significantly differ from the song of another whale at the unit level. These small scale signal differences may represent physical or fitness differences between singers. If such signal differences are detectable by other whales, they may provide a basis to asses the quality or fitness of the singer. Song differences may be the biologically important component that females use for mate choice. Likewise, other singers would have the ability to assess the relative fitness of neighboring singers.

ABUNDANCE AND DISTRIBUTION OF CETACEANS IN CALIFORNIA - A CURRENT AND HISTORICAL OVERVIEW.

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The California Current System is a highly variable coastal marine environment, with large inter-annual and seasonal variation. During 1991 and 1992, aerial and shipboard line transect surveys were conducted along the California coast to obtain information on the distribution and abundance of marine mammals. The surveys were designed to complement each other seasonally, with the aerial surveys conducted in winter/spring 1991 and 1992, and the shipboard survey conducted in summer/fall of 1991. Shipboard surveys conducted along the California coast in 1979-80 provide a basis for historical comparison.

A total of 22 cetacean species were sighted on the 1991-92 surveys, including one rare North Pacific right whale. Statistically significant ($\alpha = 0.05$) seasonal changes in abundance were observed for Pacific white-sided dolphins and blue whales. For Risso's dolphins and northern right whale dolphins, smaller seasonal changes in abundance are suggested. A seasonal shift in the distribution of northern right whale dolphins was also documented. The most abundant species during both surveys was the common dolphin. A historical comparison reveals that this species has increased considerably in abundance during the last 10 years. Furthermore, previous studies had indicated strong seasonal changes in abundance of common dolphins, but the two new abundance estimates are remarkably similar. Blue whales also appear to have increased in abundance during the last decade. In contrast, the abundance of temperate delphinids (northern right whale dolphins and Pacific white-sided dolphins) has apparently decreased, and short-finned pilot whales have virtually disappeared from California waters.

CETACEAN ABUNDANCE IN THE GREAT SOUTH CHANNEL AREA

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The Great South Channel (GSC), a deep water channel dividing Nantucket Shoals and Georges Bank east of Cape Cod, Massachusetts, is a seldom studied but productive feeding area for many cetaceans. Data were gathered in the GSC over a ten year period from commercial motor vessels, from one to four months between June and September. Comparisons were made between years and between months, with an emphasis on humpback and fin whales. Cetaceans observed most frequently were humpbacks (Megaptera novaeangliae), fin whales (Balaenoptera physalus), minkes (B. acuturostrata) and Atlantic white-sided dolphins (Lagenorhynchus acutus). Abundance varied significantly between years with a peak in 1989 and 1990. The GSC is an area where highest cetacean abundance coincided with abundance of American sand lance (Ammodytes americanus). Within years, many humpbacks and fin whales, particularly cow/calf pairs, were recurrently sighted in the GSC and on Stellwagen Bank (STB), another feeding area 100 miles north. A contingent of exclusively GSC humpbacks was also discovered, many resighted over two or more years.

VISION AND SPERM WHALE FORAGING

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A diverse body of evidence suggests that vision is critical for a wide variety of mesopelagic organisms. The supposition that sperm whales depend exclusively on echolocation to detect their preferred prey, squids, is challenged by several arguments, including the unfavorable acoustic target strengths of these animals. Two foraging techniques are discussed; both are consistent with recent acoustic tag data that reveal a steady pattern of movement during dives. Whales may see their prey silhouetted against the downwelling surface light. Alternatively, whales may use stimulated bioluminescence to lure prey. Both of these hypotheses have general application to foraging and anti-predator defenses in the open sea.

OLIGOCENE FOSSILS AND THE ORIGIN OF PLATANISTOID DOLPHINS

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Austral fossils indicate that platanistoid dolphins are an ancient group once more diverse and widespread than today. Newly discovered archaic marine platanistoids (late Oligocene to earliest Miocene, 22-24+ M years old) from New Zealand have small, slightly asymmetrical, telescoped skulls and long rostra with heterodont teeth. Facial and basicranial features are consistent with echolocation. New species include two in a new family and one probably in the enigmatic Dalpiazinidae. All lack the obvious features of Platanista and Platanistidae (e.g. facial crests, pterygoid lateral lamina), but the basicranium and tympano-periotic indicate platanistoid affinities. Cladistic analysis (PAUP 3.1.1) suggests that: 1, NewFamily + Dalpiazinidae perhaps form a sister group to Platanistidae + Squalodelphidae; 2, the shark-toothed dolphins (Squalodontidae) are also platanistoids; 3, Delphinoidea, Ziphiidae, and Physeteroidea are progressively more basal sister taxa within the Odontoceti. The global fossil record shows that platanistoids declined in taxonomic, geographic and ecological diversity as delphinoids radiated in the last 10-15 M years, but the functional morphology and paleoecology of delphinoids and platanistoids is known too poorly to be sure that this reflects ecological displacement.

INTERACTIONS BETWEEN DOLPHINS (TURSIOPS TRUNCATUS) AND HUMANS DURING CONTROLLED SWIM PROGRAMS

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Communication among dolphins, trainers, and swimmers can be a key factor influencing risks during "swim-with-the-dolphin" programs. The interactions of 6 captive-born bottlenose dolphins were video-taped during "swim-with-the-dolphin" sessions (n = 17) at Dolphin Research Center, Florida. A swim session consisted of 4 swimmers, 2 dolphins and 1 trainer; sessions were repeated 3 times for each swimmer group. The most frequent interactions requested by trainers were "imitate" and "push swimmer". The most frequent spontaneous dolphin-initiated interactions were "swim alongside swimmer" and "dorsal pull"; both previously had been reinforced. Predictability of spontaneous, interactive dolphin actions increased over the 3 repeated swim sessions; whereas, correct responses to trainer signals declined on the second and third sessions (G^2 = 10.94; df=2; p<.05). Spontaneous dolphin interactions were non-random given the previous behavior of swimmer (G^2=501.03; df=5; p<.001) and trainer (G^2=14.16; df=5; p<.05). Five occurrences of behaviors that may have been indicative of disturbance or agonistic states were observed, yet none resulted in serious consequences. We suggest that an optimal amount of control, predictability and novelty provided during "swim-with-the-dolphin" programs may be effective in reducing the probability of stress and risk. However, these data will need to be compared with future studies of other swim programs to evaluate such questions appropriately.

THE USE OF U. S. NAVY IUSS PASSIVE SONAR TO MONITOR THE MOVEMENT OF BLUE WHALES

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As the Cold War approached in the early 1950's, national security concerns increased, and the Hartwell Committee reported the potential to passively detect and identify submarines along the U. S. Coastline. Facilities were constructed and built a network of hydrophone arrays into the Integrated Undersea Surveillance System (IUSS). Throughout the Cold War, many ocean sounds were detected, all but those from submarines were ignored. At the end of 1992 the Navy initiated the Whales '93 program to evaluate the potential of IUSS to assist with assessing population, seasonal distribution and migration of five marine mammal species. Four species have been identified and tracked at various latitudes, in different ocean basins. In February, 1993, a blue whale was passively detected NE of Bermuda. Navy analysts identified "Ol' Blue" using IUSS hydrophone arrays and equipment designed to track submarines. Ol' Blue provided thousands of high intensity signals as it tracked past Bermuda to a point 200nm NE of the Bahama Islands before returning north. This particular blue whale sound was passively tracked for a period of 43 days as the animal transited over 1,450nm. The sounds were produced in sets that included up to 25 repetitions of an FM sweep. The time between sweeps was exact over all detections for 43 days resulting in a "fingerprint" used to differentiate Ol' Blue from other blue whales. The track, daily vociferation routine, and signal characteristics of Ol' Blue will be discussed.

VARIATIONS IN FIN WHALE ABUNDANCE AND TEMPORAL DISTRIBUTION IN THE SOUTHERN GULF OF MAINE: EPISODIC INFLUXES OF THE THUNDERING HERD

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Fin whale (Balaenoptera physalus) distribution on northern Stellwagen Bank and southern Jeffrey's Ledge varied widely through the years 1984 to 1992. Data were collected from commercial motor vessels between April and October, with effort concentrated from mid-June to mid-September. The field season was divided into 28, 7 day periods and data was analyzed to determine relative abundance and mean group size. Comparisons were made within years and between years. Although fin whales per hour ranged significantly between a low of .59 in 1985 to a high of 1.72 in 1989, group size remained essentially consistent, with a mean of 1.43. All years were characterized by brief invasions of a large number of animals, where both abundance and group size varied significantly from the mean. These influxes were centered in late July and early August, but occurred as late as October in 1985. Photo-identification techniques were used to determine the individual composition of these episodic groups.

MOVEMENTS AND BEHAVIOR OF SATELLITE TAGGED SPOTTED SEALS IN THE BERING AND CHUKCHI SEAS

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In August 1991, satellite linked tags (PTTs) were attached to four spotted seals (Phoca largha) captured near a coastal haulout at Utukok Pass in the northeastern Chukchi Sea. The locations and diving behavior of the seals were monitored for periods of 64-259 days. Usable position information was obtained for about 50% of the days that PTTs were operational. During August-October seals made long feeding trips southwestward into the southern Chukchi Sea and returned to haulouts at Kasegaluk Lagoon. Lengths of at sea periods ranged from 8 to 902 hours, and the four seals spent an average of 7% of their time hauled out on land. Three seals with still functioning PTTs began their southward migration in mid-October, and passed southward through Bering Strait in November. Two seals whose PTTs worked into March-April spent the late winter and early spring in the sea ice of the central Bering Sea. Haulouts on ice were also infrequent, with seals hauled out only 6% of the time, on average. The number of dives to depths greater than 10 m averaged 160 and 284 per day for two seals. All dives were to depths less than 100 m, and most lasted for less than 10 minutes.

A COMPARISON OF THE ROBUSTNESS OF THE KOLMOGOROV-SMIRNOV GOODNESS OF FIT TEST AND THE NEAREST-NEIGHBOR ANALYSIS TO DETERMINE CHANGES IN PATTERNS OF DISTRIBUTION OF MIGRATING BOWHEAD WHALES (*BALAENA MYSTICETUS*) IN THE PRESENCE OF INDUSTRIAL ACTIVITY IN CAMDEN BAY, ALASKA (1982-1992).

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A 10 year historical database of bowhead whale aerial survey sightings in Camden Bay, Alaska compiled from the years 1982-1992, provided a total of 571 bowhead sightings with associated latitude/longitude positions. A Kolmogorov-Smirnov (K-S) two sample goodness of fit test is a non-parametric test that is sensitive to differences in location and dispersion between two distributions. The K-S test results were generated by assigning sightings to one of five latitude bins each 10km in width and ranging from 70.00N to 70.50N. A comparison between the areas distant to industrial activity and the areas proximal to the activity can detect whether distributional shifts occur if animals move from nearshore bins to offshore bins.

A Nearest Neighbor Distance (NND) analysis provides an index of dispersion, or spatial distribution, of objects in an environment. For this analysis the sightings were categorized by one (1) degree longitudinal bins from 142.00W to 148.00W and nearest neighbor distances were calculated for all pairs of sightings within the bin. A ratio of observed distances to expected distances (R) was calculated for each bin to compare changes in dispersion patterns with proximity to industrial activity.

Preliminary results suggest that NND analysis is a more accurate method for determining distances from industrial activity where changes in dispersion patterns might first occur. K-S analysis appears useful as a predictive test in order to establish the sample size required to detect distributional shifts during the process of experimental design. They may be most appropriately used in conjunction to establish the robustness of a result. Used independently each test can be sensitive to small sample sizes.

POPULATION STATUS OF GUADALUPE FUR SEALS, Arctocephalus townsendi

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The population size of Guadalupe fur seals, Arctocephalus townsendi at Isla de Guadalupe was determined by censusing the entire east coast, three times per year during 1991 and 1992. Adult and subadult males counted in summer 1992, were added to the total population counted in winter to estimate the population size. This estimate was 7,348 individuals. Mean pup production for 1991-1992 was 1,222 ± 459. The total population was greatest during summer breeding seasons of 1991 and 1992 ($\bar{x}$= 5,625±128) followed by the weaning period in winter (February - March) ($\bar{x}$= 3,641 ± 1,499). Fewer numbers were counted in fall (November - December) than at any other time of year ($\bar{x}$= 3,588 ± 833). The fur seal population decreased in 1992 due to an estimated 36% mortality of pups caused by a combination of El Niño and Hurricane "Darby" that struck the island during the peak of the pupping season.

ASPECTS OF HEALTH STATUS AND POLLUTANT LEVELS IN HARBOUR PORPOISES *PHOCOENA PHOCOENA* (L.) STRANDED ON THE DUTCH COAST, 1990-1993.

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Blubber, liver and kidney samples of ca. 30 stranded harbour porpoises from the Dutch North Sea have been analyzed for organochlorine contaminants such as pesticides and PCB's. Levels of dioxines and planar PCB's were also determined within a subsample.

Pathological findings of these animals and their relation with selected biological parameters will be discussed. Special emphasis will be put on the findings related to endocrinological disorders like those of the adrenal and mammary glands.

mtDNA GENETIC VARIATION WITHIN AND AMONG POPULATIONS OF EASTERN TROPICAL PACIFIC SPINNER DOLPHINS (*STENELLA LONGIROSTRIS*) AS DEFINED BY MORPHOLOGICAL INDEX, FISHERY STOCK, AND SCHOOL

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Genetic variation in spinner dolphins from the Eastern Tropical Pacific was studied using sequences from the D-loop region of mtDNA. Total DNA was extracted from liver tissue following standard protocols, enzymatically amplified by the polymerize chain reaction (PCR) and sequenced using dideoxy sequencing methods. Forty-three samples were analyzed. Pair-wise genetic relatedness among and within populations were examined using AMOVA, a public-domain computer program designed to study DNA divergence in an analysis of variance format. Individuals were stratified based on morphotype index defined by color pattern and dorsal fin shape; fishery stock type defined by appearance of the majority of the adult dolphins within a school, i.e., whitebelly or eastern; and school membership. Preliminary results indicate that the stratification based on school membership is only one that is statistically significant--individuals are significantly more closely related to their school mates than they are to others outside their schools.

TERRITORIAL BEHAVIOR AND REPRODUCTIVE SUCCESS OF MALE CALIFORNIA SEA LIONS IN THE GULF OF CALIFORNIA

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We present data on the territorial behavior of male California sea lions *(Zalophus californianus)* during the breeding season on I. Angel de la Guarda (Gulf of California) and its relationship to reproductive success. Data were collected from 1985-1990. Three major territorial strategies were seen: males fought for and held territories in the early-, mid-, or late-season. Early-season males arrived and left their territories in May, and did not mate. Mid-season males held territories from May to August (tenure = 62.9 days). They had more copulations per day of tenure than did the other categories of males, and had significantly greater numbers of copulations (66% mated). Late-season males arrived on territories near the end of the mating season and only a few mated (4.5%).

The behavior of territorial males was categorized as resting, aggression, patrolling, and interacting with females. Significant differences were found among the mid- and late-season groups. The data suggest that the reproductive success of these males is influenced by their age, arrival date and tenure on territory, and by their behavior towards females.

PHYSIOLOGY OF REPRODUCTION IN HARBOUR SEALS.

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The reproductive cycle of phocid seals maybe divided into three main periods: embryonic diapause, active gestation and lactation. This project aimed to investigate the changing sensitivity of the pituitary gonad axis to challenges of exogenous gonadotrophic hormone (GnRH) throughout the year. 10ug of GnRH was given to six captive harbour seals of varying sex and maturity. Blood plasma concentrations of luteinizing hormone (LH), follicle stimulating hormone (FSH), progesterone and testosterone were then measured using either a radio-immuno or an ELISA assay system. LH concentrations increased immediately following injection of GnRH, reaching peak concentrations within 10-30 minutes. FSH concentrations did not increase. The steroid concentrations showed a delayed response to GnRH. Testosterone increased within 20-30 minutes and progesterone within 10-30 minutes following GnRH. The LH responses varied in relation to maturity and the time of year. One mature female produced responses of a similar magnitude all year. In contrast the responses from the immature male and females varied through the year with their lowest responses occurring in December/January.

REPRODUCTION IN THE ATLANTIC WALRUS (ODOBENUS ROSMARUS ROSMARUS) OF FOXE BASIN, NORTHWEST TERRITORIES, CANADA

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The reproductive status of 71 female Atlantic walrus, (Odobenus rosmarus rosmarus), was determined through macroscopic inspection of their reproductive organs. Samples were collected in July of 1988, 1991 and 1992, during native walrus hunts in northern Foxe Basin. No evidence of past or present ovulation was found in animals less than 5 years old. The ovulation frequency of mature animals was 0.50, suggesting a reproductive cycle greater than one calender year. Eighteen of 29 ovulated animals carried identifiable fetuses. The youngest pregnant animal in the collection was 6 years old. A corpus luteum found in the absence of a fetus may have been associated with delayed implantation or it may represent a pseudo-pregnancy. The proportion of animals with a corpus luteum and a macroscopically identifiable fetus varied between years and may reflect plasticity in the mean date of implantation. Seventeen of 29 mature walruses which had not ovulated in the last cycle showed evidence of recent parturition. The reproductive organs of 12 mature animals appeared quiescent. Anomalies or pathologies were discovered in 3 female reproductive tracts. Hunter selection bias may preclude extrapolation of results to the natural population.

A PROTOTYPE PEN-BASED COMPUTER SYSTEM FOR RECORDING LINE TRANSECT SIGHTING DATA

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A prototype computer system for recording line transect sighting data is described. The hand-held pen-based unit running PenDOS uses a stylus for data entry through automated character recognition and menu selection. A program was created using the Pen Pal application development system to accomodate the specific requirements for multiple sighting team line transect surveys; data entered include species, time, estimated range and bearing, swim direction, group size, behavior, and free-format comments and diagrams. The system allows new sightings to be initiated while previous sightings are pending. Data fields can be filled in any order. All data fields for a sighting are displayed in a single screen, making incomplete records apparent; entries are checked for appropriate values. Data are recorded on removable PCMCIA 2MB memory cards, each capable of holding data from more than one day's searching effort. The system allows all team members to easily and reliably record their own sightings data with minimal interuption to searching effort. Plans are being made for incorporating sighting effort data, vessel log data, and for real time transmission of sighting data to a host computer using radio frequency tranmission.

A CLOSER LOOK AT ATTENDANCE IN NEOPHOCA CINEREA: TIME ON LAND VS. TIME WITH PUP.

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Attendance cycles of sixteen female Australian sea lions, and the amount of on-land time they spent with their pups, were studied from December 1989 to March 1990. The females and their pups were marked for individual recognition, with dye or bleach (respectively) on the pelage. During the study the rookery was checked three times each day for the presence and location of the marked individuals. Although the mean length of the females' on-land intervals remained constant as the pups aged from one to three months (34.7 ± 8.2 hours, 35.4 ± 9.9 hours, and 30.4 ± 10.9 hours, respectively), the females spent significantly increasingly less of their on-land time with the pups (Kruskal-Wallis, H = 15.06, p < 0.001, n = 16). The mean percent of on-land time that females spent with pups was 85.04% ± 7.87 for pups 0-1 month old, 70.74% ± 14.64 for pups 1-2 months old, and 66.40% ± 14.99 for pups 2-3 months old. Since females and pups spend this time apart from each other, the amount of time the females are on land may not be an accurate measurement of maternal investment. Pups may become more efficient at suckling as they grow, and thus may need to spend less time suckling. Also, pups need less protection as they age, and they spend more time interacting with other pups. Females may use time on shore for "rest", in addition to pup nourishment.

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PRELIMINARY RESULTS OF THE SPRING 1993 CENSUS OF BOWHEAD WHALES, *BALAENA MYSTICETUS*, OFF POINT BARROW, ALASKA

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The 1993 census marked the 14th ice-based census of the Bering Sea Stock of bowhead whales conducted off Point Barrow, Alaska. The main objective of the census is to provide population data to be used in setting harvest quotas for the subsistence hunt of bowhead whales by Alaskan Eskimos. The census has two components: a "traditional" visual count and a passive acoustic location system--added in 1984. The acoustic component uses a 3 to 5 element hydrophone array to locate calling bowheads. The two data sets are combined using a whale "tracking" algorithm to produce an estimate of migrating whales. Success of the census is highly dependent on environmental factors such as percent ice cover (in the leads) and visibility. The 1992 attempt failed, for instance, due to persistent closed leads while the 1993 season experienced particularly good environmental conditions. In 1993, a total of 3,381 bowheads were seen of which 64 were calves and 49,000 calls were logged in 1067 hr of watch. The 1993 visual count is 62% higher than the previous high count in 1988. However, we suspect that the unusually good visibility and possibly that whales were distributed closer to shore explains much of the observed increase. The combined estimate from 1988 (and current *best* estimate) is 7,500 whales (95% confidence interval 6,400- 9,200). Acoustic calibration tests to 14 km indicated range errors of < 1% to >10 % (depending on angle of shot relative to array axis) and bearing errors of about 1%. Examination of census data from 1978 to 1988 showed an approximately 1% annual population increase between those years. The high visual count from 1993 suggests the upward trend of this bowhead stock is continuing, although this analysis is still underway.

15-YEAR TRENDS IN WINTER COUNTS OF FLORIDA MANATEES

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Aerial counts of manatees were conducted from 1977 to 1992, at 9 winter aggregation sites (power plants) along the east coast of Florida and at Fort Myers in southwest Florida. Counts were assessed for temporal trends. In most years, surveys were conducted after cold fronts with all sites usually surveyed during a single flight (3-10 surveys each winter, December - February). Manatees on Florida's east coast are considered one population so counts from east coast sites were pooled for each flight. Log-linear models were used to identify physical covariates that explained a significant amount of variability in the counts adjusted to yearly means. Counts were then adjusted for these covariates, and temporal patterns in the year coefficients were tested. Covariates included subjective scores of survey conditions, short-term (1- to 3-day) mean air and water temperatures at each survey site, and a series of time-lagged air and water temperature variables using NOAA degree-day summations for 5-40 days prior to each survey. Manatees used warm-water refuges most in coldest weather, so most of the temperature variables were significantly correlated to the counts. Based on the correlation coefficients, the best models for the east coast and Fort Myers populations incorporated short- and long-term summation of degree-days. Several related, relatively simple models explained 31-68% of the variation in counts. Analysis of temporal trends in the temperature-adjusted counts suggested the east coast population has increased during the 15-year period from 1977-92, while the Fort Myers population remained relatively stable. Interpretation of these results is problematic as there is no evidence to demonstrate that these counts at winter aggregation sites are reliable indicators of manatee population size.

BLUE WHALES AND *Nyctiphanes simplex* SURFACE SWARMS: A CLOSE RELATIONSHIP IN THE SOUTHWEST GULF OF CALIFORNIA, MEXICO.

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Blue whales *Balaenoptera musculus* and surface swarms of the euphausiid *Nyctiphanes simplex* were observed during February, March, and April 1984 to 1992 between Loreto (26°0'N, 111°21'W) and La Paz (24°08'N, 110°16'W) in the southwest Gulf of California. Sightings per nautical mile search in zones of 30 minute Lat-Long blocks were used to verify the relationship between the blue whale and its prey in a low latitudes region. The high correlation (r_s=0.5, P<0.01) found between sightings of blue whales and surface swarms indicated that the blue whale distibution was mainly related to food. These results are consistent with our field observation, and feces collected contained *N. simplex* mandibles. A cross correlation (lag=0, P<0.01) was found between blue whale and surface swarm sightings per year. The interannual variation in the number of both blue whales and surface swarms is discussed in relation to the El Niño/Southern Oscillation (ENSO) events reported.

ZINC AND CADMIUM RELATIONSHIP IN Delphinus delphis

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During the last years the interest in studying toxic contaminants in marine mammals is growing,and among them the heavy metals. Between certain heavy metals some biochemical interactions were detected, not only in the environment but in the organisms too; this is the case of Cadmium and Zinc.

Cadmium (Cd) is extremely toxic for the organisms and can act as antagonist of Zinc (Zn), a natural cofactor of many enzymatic systems. Due to this metabolic function, high concentrations of the latter are commonly found in different organs and tissues, whereas the Cd is incorporated with food or directly from the environment.

We report the Cd-Zn relationship in common dolphins taken incidentally in northern Patagonia (Argentina). The samples were analyzed by Atomic Absortion Spectrophotometry (air-acetilene flame) with previous acid digestion.

The Zn concentrations found were in liver 18,67-46.69 ppm in kidney 17.14-16.98 ppm and in muscle 6.16-13.33 ppm. The Cd concentrations found were in liver 6.07-6.61 ppm, in kidney 16.84-22.08 ppm and in muscle 0.06-0.14 ppm.

This distribution show the lowest Cd-Zn ratio in kidney, being this the most important concentration organ of Cd. Its filtering function and the presence of metal-binding proteins are probably the cause of this trend.

DISTANCE MEASUREMENT TO MARINE MAMMAL SIGHTINGS USING HIGH-RESOLUTION VIDEO

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Accurate measurement of distance from sighting platform to marine mammal is critical for line-transect surveys. We employed high-resolution video cameras with telephoto lenses to record marine mammal sightings during a July-November 1993 cruise. After capturing video frames on a computer, we estimated distance from ship to mammal by measuring the angle of declination from the horizon in the video image. The ship's radar was used for calibration. Distances measured by eye, by reticles in 7X and 25X binoculars, and by this video system were compared for accuracy and precision.

UNDERWATER AUDIOGRAM OF A WEST INDIAN MANATEE (*Trichechus manatus*)

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While Sirenians are threatened throughout the world, little is known of their sensory biology and behavior. This is the first underwater audiogram documented for any Sirenian species. Two 7-year old captive born males have been trained for this study. Using a two-choice paradigm, the tests are conducted at the Lowry Park Zoo in Tampa, Florida. The results reported herein are from one animal which has completed the pure-tone audiogram. One year was required for site preparation, special equipment and software development, animal training and rough testing frequencies to define gross hearing limits before actual thresholds could be tested. All threshold sessions and much of the preliminary training was recorded on time-coded video and synchronized computer logs. Time-stamped spectral analysis plots further document each threshold trial and provide detailed acoustic records for trial specific signal-to-noise analysis. Over a 9-month period, 4000 trials were run. Auditory thresholds for 19 frequencies were measured using an up/down staircase psychometric technique. The subject's reliability averaged > 90% correct for control trials. The resulting audiogram demonstrates a wider range of hearing than previous evoked potential, morphometric and behavioral pilot studies suggested (.015-46 kHz). The manatee can successfully detect infrasonic and ultrasonic pulsed signals. The audiogram is a typical mammalian hearing curve. The manatee's most sensitive range is 6-20 kHz. However, below 3 kHz the manatee still demonstrates greater low-frequency sensitivity than all other marine mammals tested. Below 800 Hz sensitivity falls off and threshold variability at 400-500 Hz suggests the manatee switched strategies from listening to "feeling" difficult-to-hear frequencies. Hearing thresholds of 48-50 dB (*re*:1μPa) for peak frequencies are comparable with other marine mammal threshold levels. The manatee's auditory sensitivity at 10-32 kHz is surprising, as this extends well above the manatees' range of pulsed vocalizations (.5-10 kHz). This high-frequency hearing ability may be exploited for directional cueing.

OBSERVABLE SURFACE BEHAVIOR AND VENTILATION OF BLUE WHALES IN THE ST.LAWRENCE ESTUARY

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Over 60 hours of observations of individually recognizable whales were made from an inflatable boat between June and September 1991 and 1992. A total of 17 different whales were tracked for mean periods of 165 minutes (min 60; max 237). Seven ventilation parameters were analysed: dive time, surfacing time, blow interval, number of blow per surfacing, mean blow interval, blow rate and percent of time at surface. The two most variable were selected and used with 8 other descriptors of the behavior to characterize each surfacing sequence. Descriptors included speed and dynamic level of swimming, surface geometry of path, distance covered from last sequence, immediate group size and coordination, distance to nearest neighbor and the occurence of special surface behavior. Parameter values from each sequence were included in a set of matrices. Various analytical methods are considered to identify *a posteriori* surfacing patterns that could be related to activity classes.

A TEST OF TWO PHOTOGRAMMETRIC MEASURING INSTRUMENTS USED TO DETERMINE DOLPHIN LENGTHS FROM VERTICAL AERIAL PHOTOGRAPHS

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Two photogrammetric measuring instruments (a stereo-comparator and a video-imaging system) having different, yet complementary features are used to derive body length frequency data from vertical aerial photographs of eastern tropical Pacific (ETP) dolphins. Length frequency distribution data derived with these instruments are used to help describe and manage dolphin populations subjected to mortality in the ETP purse-seine fishery for tunas. Because these measuring instruments differed in design and image presentation, we conducted an experiment to test the hypothesis that there was no difference between instruments in dolphin image measurements. Results indicated no significant difference in length measurements due to measuring instruments, readers, replicate measurements or interactions of these factors. Length measurements were precise (averaged < 1.0% coefficient of variation) and 95% confidence limits of the means (averaged ±1.2 cm) were within the range needed to detect the small length differences (minimum: 2 - 3 cm) found between certain ETP dolphin populations.

DISTRIBUTION OF WALRUSES IN THE NORTHERN BARENTS SEA: A LINKAGE BETWEEN SVALBARD (NORWAY) AND FRANZ JOSEF LAND (RUSSIA).

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The distribution of walruses in Svalbard and Franz Josef Land have been mapped using satellite telemetry (A total of 33 PTTs have been deployed over a four year period, 27 in Svalbard and 6 in Franz Josef Land), surveys and information from historical sources. The results of this study indicate that walruses in these two neighboring archipelagos mostly stay within their own geographical areas, but that Svalbard bull-walruses occassionally make short trips to Franz Josef Land. This is assumed to be related to an observed sexual segregation between animals in the two areas: Females and calves are today rarely observed in Svalbard, except in the far eastern areas, whilst they are abundant in Franz Josef Land. This leads us to believe that the walruses in these two archipelagos are part of a common population.

OCCURENCE AND ANALYSIS OF MUCOUS SECRETIONS OF HUMPBACK WHALES

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Humpback whales, *Megaptera novaeangliae*, in Hawaiian waters can produce calves at a one year reproductive rate. It is unknown, however, if postpartum ovulation is occurring due to the loss of the calf. "Active groups" of whales, consisting of a female, a dominant male escort, and one or more male challengers fighting to overtake the escort, have been frequently seen throughout our long-term study. The purpose of these groups is to lead to pair formation between the female and the dominant male, which we believe results in mating. Of 402 sightings of "active groups", 201 (50.0%) have contained a female accompanied by a calf.

During our 1992 and 1993 field study, mucous secretions from mothers and calves were sighted on three occasions, one of which was seen to come from the genital slit of the mother. Two samples were collected, frozen, and sent to the University of Hawaii for hormone analysis and microscopic examination by S. Atkinson. One sample, approximately 4 ml, was found to contain measurable quantities of estrone sulfate, approximately 80 pg/ml, but contained no testosterone. Microscopic examination yielded strong evidence for presence of poorly preserved cornified epithelial cells. Various planktonic forms were also present. The second sample contained the same type of cornified epithelial cells but did not yield testosterone or estrogen. However, the quality of this sample was degrading, as compared to the first.

The mother and calf whose sample contained estrogen and the mother and calf whose secretion was not collected, were seen in "active groups" of whales. The presence of estrogen and epithelial cells in the mucous secretion helps support the theory that the formation of active groups eventually lead to mating. We postulate that postpartum ovulation may be occurring in lactating females without the previous loss of a calf.

CURRENT STATUS OF THE MEDITERRANEAN MONK SEAL (Monachus monachus) POPULATION INHABITING THE SAHARA COAST

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The Mediterranean monk seal population inhabiting the western Sahara is the only large cohesive aggregation of the species and possibly the only viable population in the long-term. Information about its status and biology, however, was impeded by the local war from 1976 to 1991. In 1992-1993, we carried out three expeditions and established a field camp in the area to survey seal distribution, abundance, biology and conservation problems. Results indicate that monk seals concentrate in at least four caves, and that previous population estimates, based on short visits to the main caves, are of limited reliability. Visual monitoring of seal activity and photoidentification techniques have been used to study patterns of haul-out behaviour and movements between caves. Results indicate that the population is over 85 seals (photoidentification has permitted the identification of 25 individuals to date). The finding of 41 corpses, some of them recent, suggests high levels of mortality. Some of these deaths were due to human interference, particularly fishing interactions.

Study supported by the Nature Heritage Fund and ICONA.

UNEXPECTED SUBSTRUCTURING IN THE EUROPEAN HARBOUR SEAL POPULATION REVEALED BY MICROSATELLITE DNA POLYMORPHISMS

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The 1988 Phocine Distemper Virus (PDV) epizootic affecting European harbour seals (*Phoca vitulina*) highlighted the lack of information available on individual movements and genetic relationships between subpopulations in this species. Tagged individuals have been known to travel substantial distances, up to 500km. If emigration followed by reproduction is common, genetic substructuring will be weak or nonexistent. However, a striking feature of the PDV epizootic was the variation in mortality between subpopulations, a contributing explanation for which could be genetically determined differences in susceptibility.

We present the results of an analysis of DNA polymorphisms at microsatellite loci, which demonstrate that the European harbour seal population is highly substructured, indicating a low effective movement of breeding individuals between subpopulations. To date all loci, originally cloned from harbour and grey seals (*Halichoerus grypus*), with relatively low heterozygosity show significant genotype frequency differences between subpopulations in different parts of the North Sea. These results provide the necessary preconditions for a genetic contribution to mortality in the PDV epizootic. We intend to investigate this possibility further by looking for systematic patterns relating genotype and mortality during the epizootic both across and within subpopulations.

THE FIRST WHALE ECG WITH A SELF-CONTAINED TAG AND, RADIO AND SATELLITE-LINKED DEPTH AND HEART-MONITORING TAGS FOR WHALES

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A digital human Holter monitor was modified and incorporated into a suction-attached tag for recording whale heart ECGs without hardwire connection to a boat or shore-based recorder. Software and hardware options allowed sampling rates to 240/sec with selectable signal input resolution from 1-10μvolts. An initial test on a beluga whale (Delphinapterus leucas), allowed to swim freely within a large aquarium tank, provided several clear ECG sequences from a sampling rate of 120/sec and resolution of 1 μvolt. Some sequences were obliterated by noise possibly due to electric aquarium pumps or other sources. The same tag provided a clear ECG of a harbor porpoise (Phocoena phocoena) held out of water. Two suction cups were modified to hold the electrodes which were placed above each pectoral fin on both cetaceans. A third electrode was fixed to the housing and left exposed to the seawater. Field placement of this tag onto free-swimming whales will be done by pole which will limit options in placing the electrodes. Further testing on aquarium animals will focus on optimizing electrode design so tags can be deployed by a pole onto free-swimming whales. A second, microprocessor-based data logger was developed for interfacing with microprocessor-based VHF radio and Argos satellite-linked transmitters and incorporation into a whale monitoring tag. This system has 8 to 16 channel-sensor capability. The data logging component was successful in lab tests. VHF and satellite-linked whale tags set up to record and retransmit temperature, depth, heart rate, and acceleration will be tested on free-swimming whales this fall. The primary support for this research has been provided by the Office of Naval Research.

RISSO'S DOLPHINS GRAMPUS GRISEUS IN SUBANTARCTIC WATERS

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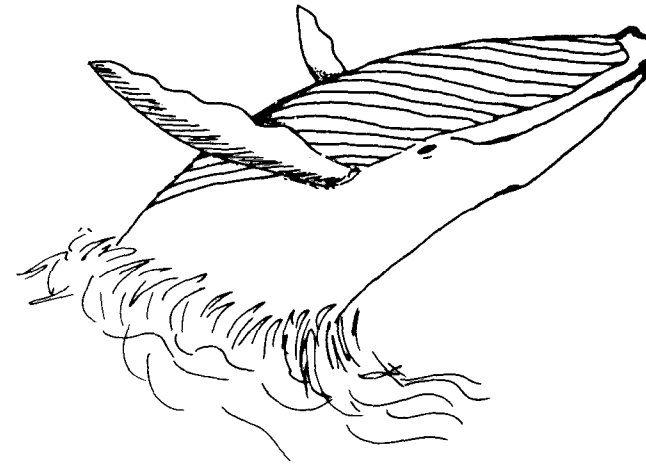
Risso's dolphin is widely distributed in warm and temperate waters, but in South America only a few records are known for Perú, Chile, Brazil, Uruguay and Argentina, all in warm waters. This species seldom is found in cold regions. During the first five years of our surveys for stranded cetaceans in Tierra del Fuego (TF), we found no Grampus specimens, although four were found along the Strait of Magellan, Chile, in 1978. Since 1981, *Grampus* strandings have increased in eastern Tierra del Fuego. Most events were mass strandings, ranging from two to at least 14 individuals. The largest northern hemisphere mass stranding was of five animals. At least five events have occurred in the WSW sector of Bahía San Sebastián. There have been sightings for this area and in the Beagle Channel.

Of 73 animals examined, sex could be determined for 33 males and 6 females. Some males had false mammary slits. Total lengths for 60 animals ranged from 206-338cm (mean 299.7), with all but two animals over 240cm. Males ranged from 221-338cm (n=32, mean 304.7), all but one over 260cm. In other areas, males are sexually mature at 260-300cm. Females ranged from 273-313cm (n=5, mean 299) and those of unknown sex 206-336 (n=23, mean 293). None of the 17 skeletons examined to date had complete ephyseal fusion.

There were 3-5 (n=50) mandibular teeth per side, the most frequent combination being 4/4 (54%). As found for South Africa (Ross 1984), this is less than northern hemisphere *Grampus*, with 2-7 teeth per side. One TF animal had 2 small upper teeth. Preliminary GLG estimates range from 2-21.5 years; the maximum age known in this species is 34 years. Of 13 stomachs, 9 were empty. The others had meagre quantities of squid beaks, fish bones or algae. One stomach contained five plastic bags of different colors and sizes.



PRELIMINARY RESULTS FROM A SURVEY TO ESTIMATE DOLPHIN DENSITY ON THE FRENCH ALBACORE TUNA FISHING GROUNDS IN THE EASTERN NORTH ATLANTIC.

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In 1992, IFREMER initiated a research programme to assess any ecological risk associated with the French albacore tuna driftnet fishery in the eastern North Atlantic. An integral part of this programme is to estimate the density of those species of dolphins taken incidentally by the fishery.

In 1993, a shipboard sightings survey was conducted during July and August, the period of peak activity in the fishery. The data were collected and analysed using standard line transect sampling techniques, with the aid of the recently developed program DISTANCE.

In this poster, the preliminary results of the survey will be presented.

CETACEAN DISTRIBUTION AND ABUNDANCE OFF OREGON AND WASHINGTON

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Twelve aerial surveys and one shipboard survey were conducted off the coasts of Oregon and Washington between April 1989 and September 1990 to determine the distribution, abundance, and habitat use patterns of cetaceans. A total of 14 species of cetaceans were observed during the study which included 381 mysticetes (6%) and 5,892 odontocetes (94%). Population estimates were calculated for the four most commonly observed species: Risso's dolphins (7,700), Pacific white-sided dolphins (38,000), harbor porpoises (4,800), and Dall's porpoises (2,150). We found gray whales to migrate considerably farther offshore than previously reported. Sixty-eight humpback whales were observed in the study area between May and November and were most frequently found in slope waters. Humpbacks were photoidentified and matched with whales previously photographed in California and Mexico. Risso's dolphins were found almost exclusively in slope waters. Pacific white-sided dolphins, the second most commonly observed cetacean, were found year-round, with densities were highest during the spring. Pacific white-sided dolphins were distributed across several depth zones but were most abundant in slope waters, except during spring when these dolphins were found offshore in large groups. Seasonal changes in density for Risso's and Pacific white-sided dolphins suggest north-south movements between California and the study area. Northern right whale dolphins were found in the study area during all seasons except winter with highest densities occurring in slope waters during the fall. Harbor porpoise were found year-round in the study area. Ninety-six percent of the sightings occurred in shelf waters with 5-30% of the sightings occurring between the 100-m and 200-m isobaths depending on the season. Dall's porpoise were also distributed across all depth zones except waters < 100 m deep. Distribution shifted seasonally from the outer shelf (100-200 m) in the summer and fall to offshore during the winter and spring.

IS THE HIGH MORTALITY OF SOUTHERN RIGHT WHALES, EUBALAENA AUSTRALIS, ALONG THE SOUTH BRAZILIAN COAST DUE TO ANTHROPOGENIC FACTORS?

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A search for information on beachings and strandings of southern right whales, Eubalaena australis, and expeditions along the beach resulted in 15 cases in the period from 1987 to 1992 for the Rio Grande do Sul State (RS) coast (29°19'S, 33°45'W). Mostly, the beachings occured during the months of September and October but have also been recorded for the end of August and beginning of November, coinciding with the period when sightings of this species are more frequent in the Brazilian coastal waters. The strikingly high mortality rate for this period, compared to previous years, reinforces the hypothesis that the number of this group of southern right whales is increasing. Even though the low declivity and big extension of the continental shelf of RS are favorable to stranding events, evidences such as the increment of the local marine traffic from 1983 to 1992 and great part of the whales being confirmedly beached, one of these whales presenting ship propeller marks and another the body cut in half by a steel cable, suggest that the elevated number of dead whales found in the region is related to human activities.

FROM PLANKTON TO WHALES; A STUDY IN IDENTIFYING CHARACTERISTICS OF CETACEAN HABITAT

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Distribution of cetacean groups around bathymetric (e.g. canyons, shelf-edge) and oceanographic features (e.g. thermal fronts) have been hypothesized by several investigators. Marine mammals are hypothesized to favor these regions of high physical and biological gradient due to advantageous trophic considerations.

During the period 01 JUN 1993 to 02 JUL 1993, the Marine Mammal Investigation at the Woods Hole, MA lab of NOAA/NMFS/NEFSC undertook a shipboard survey of cetacean distribution and abundance on the eastern and southern edges of Georges Bank. During transects of the study area, (extending from the Scotian Shelf to Veatch Canyon), concurrent oceanographic and planktonic data were collected.

Data are being analyzed to investigate possible physical and biological causes for a suggested positive relationship of cetacean diversity and abundance with the presence of shelf-edge canyon environments. Presented here are preliminary results of analyses of relationships between marine mammal distribution and environmental conditions present in the Oceanographer Canyon region of Georges Bank.

UNDERWATER SOUNDS FROM HELICOPTER AND AIRPLANE FLIGHTS OVER PACK ICE AND REACTIONS OF SPRING-MIGRATING BOWHEAD WHALES

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In air, aircraft sounds are often heard by people at long distances. Only sound radiated in a 26° cone beneath the aircraft couples well into water. With a calm sea, sound incident outside the cone is reflected back into the air. Theory also predicts that aircraft sound underwater will be strongest at shallow depths. These predictions were examined in flights by a Bell 212 helicopter and a de Havilland Twin Otter fixed-wing aircraft over an ice floe edge near Barrow, AK, during spring. The results showed higher levels at lower altitudes. Rotor blade tones (11 Hz harmonic family) dominated the sound field ahead of the helicopter and tail rotor tones (55 Hz family) dominated the sound field beneath; it was much quieter behind the helicopter. At altitude 460 m, hydrophone depth 18 m, the helicopter's 20-500 Hz band level was 103 dB re 1 μPa (9-s average); the Twin Otter (with propeller blade tones in an 83 Hz family) was 3 dB quieter. No sea ice effect was noted. Helicopter passes at altitudes $\leq$150 m and lateral distances $\leq$500 m elicited obvious reactions by bowheads on 5 of 10 occasions. As in summer/fall, direct overflights by the Twin Otter sometimes elicited hasty dives or turns when aircraft altitude was $\leq$150 m, but very rarely did so when altitude was 460 m. [Supported by Minerals Management Service]

FIRST EVIDENCE FOR COLOR VISION IN DOLPHINS

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Three bottlenose dolphins were trained to discriminate between a blue and a red stimulus light in a two-choice test situation. The intensity of the two color stimuli was adjusted to equal subjective brightness on the basis of the photopic spectral sensitivity function of a bottlenose dolphin. Additionally the red stimulus intensity was varied randomly in three steps over 0.5 log. units. Two of the tested animals were able to discriminate the short-wavelenght stimulus from the long-wavelength stimulus. Obviously for dolphins color vision has some importance for contrast enhancement and object detection in a limited photic environment.

ACOUSTIC CHARCTERISTICS OF AND CONSPECIFIC REACTIONS TO AERIAL BEHAVIOR IN HUMPBACK WHALES, ON THEIR FEEDING GROUNDS IN THE SOUTHERN GULF OF MAINE.

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From April-November 1991 and 1992, underwater recordings of aerial behaviors (spinning and non-spinning breaches and flipper slapping) in humpback whales, *Megaptera novaeangliae*, were made in the southern Gulf of Maine. Recordings were made within 200 m of active whales using a hydrophone sensitive from 0.1 Hz to 60 kHz. Sound signatures produced by aerial behaviors had wide band widths characteristic of non-tonal sounds. Sounds were primarily concentrated in the low frequency range (50-3000 Hz) with mean peak sound energy at 287 Hz for slaps (n=17) and 1583 for breaches (n=7). The duration of sounds was relatively short (0.02-0.1 sec) and was similar for both activities (0.7 sec and 0.8 sec respectively), however, slaps tended to have two separate smaller components (0.02 sec each), whereas breaches primarily had one large band. Orientation of humpback whales in respect to conspecifics engaged in aerial activity was recorded from July-October, 1991. Orientation was broken into three zones: approach, avoidance, and neutral. Humpback whales did not approach whales engaged in either flipper slapping, tail breaching or spinning breach activity ($P>0.05$). During tail breaching, nearby whales significantly maintained a neutral orientation to displaying animals ($P>0.005$). Further analysis using a modified Raleigh test, indicated that, within each zone, only avoidance orientation was definitive during both spinning breach ($P<0.001$) and flipper slapping displays ($P<0.001$). For tail breaching events, no significant clustering in any zone was observed. These data are consistent with previous studies on motivation and acoustic-structure and suggest that aerial behavior in humpback whales contains an aggressive or spacing component and has an overall dispersal effect in this species.

COMPARISON OF VISUAL VERSUS PHOTOGRAPHIC COUNTS OF WALRUS GROUP SIZE

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Aerial surveys to monitor walrus movement in the presence of oil expioration were conducted in the Chukchi Sea off Barrow, Alaska, during 1989, 1990, and 1991. The primary method of assessing walrus numbers was visual estimation of group size by trained marine mammal observers stationed on both sides of a DeHavilland Twin Otter aircraft. As a secondary method for estimating walrus numbers, we developed an aerial photographic system with design assistance from the Canadian Wildlife Service. Using a 9" x 9" format aerial camera and a video camera mounted in the aircraft belly, photographs were taken simultaneous to observer estimates. The strip covered by the camera was defined for various altitudes and observers classified their counts as "in" or "out" of the camera strip. Preliminary comparison of visual versus photographic counts of walruses indicate that count discrepancies increase with increasing group size, primarily among walrus groups of >10 animals. Photography is the sole method used to estimate walrus abundance by the Canadian Wildlife Service due to the documented error associated with observer counts. Our preliminary results tend to confirm this error.

DIFFERENTIAL RELATIONSHIPS AMONG BOTTLENOSE DOLPHIN (*Tursiops truncatus*) CALVES AND ADULTS IN A CAPTIVE COLONY

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Development of behavior and social affiliations of two captive-born bottlenose dolphin (*Tusiops truncatus*) calves was recorded using point sampling from birth through the first year. Coefficients of association between each calf and each of the other dolphins present in the tank (up to seven total animals) differed over time and between focal calves. Differences in coefficients of association between each of the calves and each of the adult males are related to paternity. Further analysis will determine the influence of related versus unrelated adult males and females on infant behavioral development.

AN UNUSUAL PORPOISE (PHOCOENA PHOCOENA AND PHOCOENOIDES DALLI) MORTALITY EVENT IN SOUTHERN BRITISH COLUMBIA

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Between 10 April and 7 June 1993, 24 dead porpoises (10 Dall's porpoise, 9 harbour porpoise, 5 unidentified) were recorded in the area from Victoria to Jordan River, along the south and southwest coasts of Vancouver Island, B.C. Over the previous six years, with similar levels of observer effort, an average of 2.3 (range 1-4) dead porpoises had been found in this area in the equivalent period each year. Comparisons of sighting records of porpoises during this period with sightings from previous years indicates the large number of animals during 1993 is not due to an influx of porpoises into the area. Necropsies were undertaken on 17 animals, with samples collected for histopathology, toxicology, bacteriology, virology, and biotoxin analysis. Cause or causes of the mortality event remain undetermined. Stomachs contained fish otoliths, squid beaks, euphausiids, or were empty, but none contained fleshy remains of fish or squid. One sample of stomach fluids analyzed for biotoxins was negative. Microscopic evaluation of tissues demonstrated frequent parasitic infections but no specific indication of other infectious agents. Limited microbiological examinations were unrewarding. Levels of organochlorines and heavy metals were within the usual range for these species in this area.

IDENTIFICATION OF THE HUMPBACK WHALE POPULATION ALONG THE ECUADOREAN COAST 1990 - 1992.

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Since 1990 the Ecuadorean Foundation for the Study of Marine Mammals (F.E.M.M.) has started a data bank by collecting observations and flukeshots on a small scale. The study was mainly carried out near La Plata Island (00°16´ S, 81°06´ W) where the animals seem to concentrate frequently during their presence along the ecuadorean coast between May and October, with some variation in date of arrival. In 1991 many individuals arrived in june, about two weeks earlier than in 1990 and 1992. Although mothers with calves have been observed it is not sure that the study area forms part of the calving grounds. Besides recording songs, a total of 23 humpback whales could be photographed. One individual was photographed near La Plata Island during the "Siben Expedition" in 1988 and resighted in 1992. Quite remarkably, no whale registered in Ecuadorean waters could be identified yet in the extensive catalogue of whales that reach Gorgona Island in Colombia, just 500 km more to the north.

SHIP STRIKES ON RIGHT WHALES IN COASTAL WATERS OF THE SE UNITED STATES: A PARADIGM FOR ACTION

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Ship strikes on right whales in coastal waters of the southeastern U.S. are a major factor impeding recovery of this most endangered species. Because of the small population (~325) and the low calf production (~10/yr), the 1-3 ship strikes per year in these waters are serious. In recent years, nine agencies and institutions have joined in a mitigation and research program. Major components are: 1) the education of mariners, 2) establishment of an "early warning network" that reports the presence of right whales in and near shipping areas, and 3) research to supply the facts required by management decisions. The research includes aerial surveys (fixed-wing aircraft and airships), direct monitoring of vessel traffic, and characterization of right whales on these wintering grounds. Even though the problem is as well-defined and manageable as scientists and managers are ever likely to encounter, recent results suggest that 1) the right whale occupation of this habitat is somewhat different, and 2) the management issues more complex, than originally suspected. Increased vigor, focus, and collaboration will be required to make satisfactory progress. Only then will this work serve as a paradigm for other, perhaps more complex, contemporary science and management problems.

THE DIET OF GREY SEALS FROM ORKNEY AND THE HEBRIDES OFF THE NORTH AND WEST COASTS OF SCOTLAND.

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Almost 100,000 grey seals breed around Britain, of which 75,000 are associated with the Orkney and Hebrides island groups. The population has been increasing for several years and is an important marine predator in British waters.

We investigated the diet of grey seals by analysis of hard remains found in over 1,700 faecal samples collected in spring, summer and autumn of one year throughout the island groups. Reduction in otolith size as a result of digestion was corrected for using experimentally derived species-specific digestion coefficients.

The contribution to the diet, by weight, of sandeels (Ammodytidae) was >40% in Orkney, 20% in the outer Hebrides but <5% in the inner Hebrides. Gadids (34-53%) and flatfish (11-21%) were more consistently found but the dominant species varied by area and season. Conger eels were found only in the Hebrides; pelagic schooling fish and cephalopods only in the inner Hebrides. No evidence of predation on salmonids was found.

Mature fish of a number of species were more prominent in the diet when spawning and, in some species, larger fish were taken when they were most prevalent in the diet, suggesting some degree of prey selectivity.

POSTBREEDING MOVEMENTS OF WESTERN ATLANTIC GREY SEALS AS REVEALED BY SATELLITE TELEMETRY.

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The northwest Atlantic grey seal, Halichoerus grypus, population is increasing rapidly, raising concerns about their impact on commercial fish stocks. Half of this population breeds on the pack ice in the Gulf of St. Lawrence during December-February.

Satellite transmitters were attached to 3 adult males on the whelping patch in January. All animals moved into the Atlantic Ocean by 23 February, where they remained over shelf waters (<300 m) off the coasts of southern Newfoundland and eastern Nova Scotia until transmissions ceased during late April-early May. A total of 56,066 dives were registered. Significant changes ($p<0.05$) were observed between months in both the frequency distribution of dive depths and dive durations. While in the Gulf, and presumably associated with whelping females, 73-89% of the dives were <20 m, and 81-95% were <5 min. After leaving the Gulf, animals began diving deeper and for longer. Although 54-91% of dives were still <5 min the proportion of dives <20 m decreased to 35-69%, depending on the animal and month. Maximum depth recorded was 268 m, but dives >200 m accounted for <1% of the total number of dives.

AN ARTICULATED SKELETON OF A BALEEN WHALE FROM THE UPPER MIOCENE OF THE GERMAN LOWER RHINE EMBAYMENT

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A new discovery of a basal balaenopterid whale from the Neogene of W-Germany postmortally attacked by isurid sharks was excavated during the late 1980s. The skeleton was found embedded in a block of tertiary sands transported by inland ice during the Saalian glacial period, the reason why this material became rather crushed. Although this specimen is nearly complete, the determination of the genus is problematical in fact of its preservation. The occipital region is totally destroyed. The comparable characteristics are mainly limited to the general proportions of the cranium with special consideration on the outlines of the isolated squamosal and the elongation of the premaxillaries. Furthermore, the involucrum of the right bulla, the posterior process of the periotic, the mandibular in part and postcranial, the morphology of the axis and the humerus are useful for comparison. Another difficulty to classify this balaenopterid more precisely exists on exceedingly few anatomical differentiations in general within the fossil record of related whales due to functional adaption going hand in hand with an apparently high degree of variation in several genera.

RECENT DEVELOPMENTS IN THE TUNA-DOLPHIN ISSUE

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Dolphin mortality incidental to the tuna purse-seine fishery of the eastern Pacific Ocean continued to decline in 1992 and 1993. The estimated mortality in 1992 was 15,470, almost a 90% reduction since 1986 (133,174). The decline is due mainly to improvements in fishermen's performance, brought about by better training, higher motivation, and the adoption of an international program that imposed dolphin mortality limits on each vessel. The mortality per set (MPS) has been reduced from 13 in 1986, to 1.5 in 1992, and is projected to be <0.5 in 1993. If the effort and MPS remain stable, the projected mortality for 1993 will be about 5,000.

The research focus has shifted in recent years as well, with more emphasis on improving purse-seining and developing alternative fishing methods. This renewed emphasis has initiated research into the broader effects of fishing on the ecosystem. Alternative fishing methods are being compared not only on the basis of dolphin mortality, but on the amount of bycatches of other species and the effects on tuna populations. As an example, an ecological comparison of different types of purse-seine sets will be presented.

FINE SCALE FORAGING OF INDIVIDUAL GREY SEALS RELATED TO BATHYMETRY AND SEA BED SEDIMENT TYPE

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Studies of diet composition and analyses of dive profiles have shown that grey seals forage at or near the sea bed. Telemetry has also shown that the movements and behaviour at sea of grey seals as a population are highly variable. In this presentation, we address two specific questions: can foraging areas be characterized by bathymetry or sea bed sediment type; how much separation of foraging areas is there among individuals?

From August 1991 to January 1993 we tracked 14 grey seals from the Farne Islands off NE England using SMRU-designed ARGOS dataloggers, giving a total of 1428 days of location, dive depth and swimming speed data. Three seals made movements of 300 km or more to other major haul-out sites. All except one animal used the Farnes most of the time as a 'home base' between foraging trips mostly to a limited area within 30 km of the Islands.

Sea bed sediment close to the Farne Islands is a patchwork of gravel, sand and mud. Foraging locations were clustered in areas of sand containing 5-30% gravel; the sediment type preferred by sandeels, a major prey item of grey seals in this area. Bathymetry was not important. Several seals foraged in two small areas but individuals generally used slightly different areas indicating a degree of separation on a fine scale.

RECENT STRANDINGS OF GUADALUPE FUR SEALS (ARCTOCEPHALUS TOWNSENDI) FROM CENTRAL CALIFORNIA

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The Guadalupe fur seal (Arctocephalus townsendi) was hunted to near extinction before natural history and historical ranges were documented. The population is centered on Guadalupe Island, Mexico, but records from California have become more frequent in recent years. We report on six new records of Arctocephalus townsendi stranded along the central California coast. These include one dead adult female, one live juvenile male, and four live juvenile females. Four of the five juveniles subsequently died. Stranding sites range from the Russian River near Jenner, Sonoma County, south to Salinas River State Beach, Monterey County. Emaciation, anemia and dehydration were probable causes of stranding in all of the juvenile animals. Dietary items recovered post mortem included the beaks of the squids Loligo opalescens and Gonatopsis sp. from one, the beaks of the squid Onychoteuthis borealijaponica from two others, and the remains of a common murre, Uria aalgae, taken from the body cavity of the adult female. Two of the six animals were involved in fisheries interactions as exhibited by hooks recovered ante mortem from one and net abrasions on the fur of another. Hypotheses for northern records include an increase in the population at Guadalupe Island and natural post-weaning dispersal of juvenile Arctocephalus, combined with periodic El Niño events.

TEMPERATURE EFFECTS ON THE BREEDING DISTRIBUTION OF GREY SEALS (*Halichoerus grypus*)

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Metabolic rates of six female grey seal (*Halichoerus grypus*) pups were measured during the post-weaning fast at air temperatures between -15 and 30°C. The mean thermal neutral zone (TNZ) extended from a lower critical temperature (T_{lc}) of -7.1 ± 0.6°C to an upper critical temperature (T_{uc}) of 22.6 ± 1.0°C. Within the TNZ, mean resting metabolic rate (RMR) was 1264.1 ± 49.0 kcal d^{-1}, approximately 1.1 times the value expected for adult homeotherms of similar body mass (mean mass = 40.9 ± 1.2 kg), and relatively lower than the value observed in the same animals following the onset of feeding (2562.7 ± 123.0 kcal d^{-1}, mean mass = 53.3 ± 2.2 kg). For grey seal populations that reproduce during winter months in the eastern and western Atlantic, and in the Baltic Sea, the T_{lc} closely corresponds with the coldest mean monthly air temperature at the northern end of their breeding distribution. For late, summer-breeding grey seals on the coast of Brittany, France, the T_{uc} corresponds with the mean, warmest month, air temperatures near the southern limit of their breeding range. These observations are consistent with the hypothesis that ambient air temperatures limit the breeding distribution of grey seals through their thermoregulatory effects on small pups before they enter the water.

OBJECT REPRESENTATION IN THE BOTTLENOSED DOLPHIN (*TURSIOPS TRUNCATUS*)

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Dolphins can recognize objects by means of echolocation. They may accomplish this task by matching the sound they receive in an echo with a stored representation of that sound. Alternatively, dolphins may create object-based representations in which information about a particular object is represented regardless of the sensory system through which that information was received. Data collected with a dolphin trained to successfully match objects using vision alone, echolocation alone, and both echolocation and vision support the second alternative as the best description of object representation in the bottlenosed dolphin. A model of object representation in the dolphin will be presented.

POLLUTANTS AND POPULATION DYNAMICS OF HARBOR SEALS IN SAN FRANCISCO BAY.

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The relationship between pollutants and population changes and movements of harbor seals was examined in San Francisco Bay. The isolated southern portion of SF Bay was used during pupping and molt. Numbers near the mouth of the bay increased from Nov through Mar, coincident with winter runs of herring. Males dominated one haul-out site throughout the year (mean=86% males, SE=0.02, n=109), and females moved to this site from May through July. Harbor seals radio-tagged (n=57) in the south bay consistently remained there during pupping and molt but used other haul-out sites during fall/winter. There was limited movement outside SF Bay, thereby increasing exposure of harbor seals to pollutants in the estuary.

Elevated PCB residues in blood of harbor seals in 1989/90 prompted analysis of PCB congeners for samples in 1991/92. Mean wet wt of total PCB was 51.8 ppb (SE=10.7). PCB congener 153 was approximately 30% of the total PCB burden (mean=14.6 ppb, SE= 2.7). Blood lipid concentrations, determined using methylene chloride extraction, were a mean 0.494% (SE=0.026). Additional analyses included selected trace elements, indicators of PCB toxicity, and reproductive hormones. Some PCB levels were the greatest reported in the literature and may be affecting this population.

PREY OF HARBOR SEALS IN NORTHERN CALIFORNIA BASED ON FECAL ANALYSIS USING NEW PROCESSING AND IDENTIFICATION PROCEDURES

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Scat samples (n=159) were collected from September 1989 through August 1990 at the mouth of the Russian River, California, to determine the prey of harbor seals at that site. The samples were cleaned using the elutriating process developed at the Pacific Biological Station of the Department of Fisheries and Oceans in Nanaimo, British Columbia. In addition, rather than relying on selected elements such as otoliths, lamprey jaws, and cephalopod beaks, all elements found in the scat were used to identify prey.[1] This allowed species with delicate otoliths which are likely to erode during digestion and partially consumed prey items to be identified using other skeletal remains in the scat.

Comparison between the two identification methods showed all teleost fish, even those with more robust otoliths, would have been under-represented using only otoliths for identification, while species identified by elements more resistant to digestion (teeth or beaks) would have been exaggerated in dietary importance.

Data showed a diverse diet with seasonal shifts in the frequency of occurrence of prey items, but flatfish, octopus, hake, hagfish, and midshipmen were the most common prey remains found in the scats annually. Cusk-eel, smelt, herring, skate and perch were seasonally important, appearing in more than 25% of the samples collected in some seasons. The seasonal shifts in the frequency of occurrence of midshipmen and hake suggested nocturnal offshore feeding, as did the predation on hagfish.

The high frequency of occurrence for hake and hagfish had not previously been reported for California harbor seals and is likely a reflection of the differences that emerge when a variety of elements are used to make prey identification. A high proportion (75%) of the hake remains were identified from skeletal elements other than otoliths, and hagfish identification utilized both teeth and cartilage strips. These findings imply a greater reliance by local harbor seals on these two food sources than previously thought.

[1] Prey identification by Pacific Identification, Victoria, B.C., Canada

DEMOGRAPHICS AND POD-SPLITTING IN THE NORTHERN RESIDENT KILLER WHALE (Orcinus orca) POPULATION IN BRITISH COLUMBIA

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The resident killer whales in B.C. and Washington State are organized in matrilineal units which are very stable over time. Only a few cases of pod-splitting have been reported (Bigg et al. 1990). My initial assumption is that, since the groups are so strictly matrillineal in organization, the matriarchs are important in pod dynamics and pod structure. I am examining a 20 - year data set on whale sightings for effects of demographic events, such as matriarchs deaths, on pod organization. Preliminary results show that pod cohesion (the proportion of a group seen in any session) is uneffected by the death of a matriarch. Further longitudinal analysis will examine association patterns and their changes among individuals. The goal is to gain insight into the causes and influences in pod-splitting/ pod cohesion.

HEAVY METALS IN VERTEBRAE OF *TURSIOPS TRUNCATUS* STRANDED ALONG THE TEXAS COAST

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Heavy metals were analyzed in vertebrae of bottlenose dolphins (*Tursiops truncatus*) which stranded along the Texas coast from 1991 through 1993. Samples were collected and frozen in plastic ziploc bags by the Texas Marine Mammal Stranding Network. Dried, ground bones were digested with a nitric and sulfuric acid solution and heat. The digests were then analyzed by atomic absorption spectrophotometry for cadmium (Cd), copper (Cu), mercury (Hg), lead (Pb), and zinc (Zn). Animals in all states of decomposition were analyzed with the assumption that bone decomposition would not greatly affect metal concentration.

Percent moisture was calculated and ranged from 5% to 42%. Metal concentrations are reported in μg/gm (ppm) dry weight. Animals less than 225 cm in length had concentrations of Hg and Pb below 0.20 ppm. In animals with lengths greater than 225 cm these concentrations increased up to 1.1 ppm Hg and 1.3 ppm Pb. Cd, Cu, and Zn levels did not appear to correlate with length. Cadmium levels were low and had the least variation of the metals analyzed with a mean and standard deviation of 0.003±0.001 ppm. The range of copper was 0.5-4.5 ppm with a mean of 1.13 ppm. Zinc ranged from 372-621 ppm and averaged 483.5 ppm.

THYROID HORMONE DYNAMICS DURING THE NURSING PERIOD IN HARBOR SEALS, Phoca vitulina

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The post-natal period in phocid seals is metabolically demanding, requiring mobilization of maternal energy stores, transfer through milk, and subsequent deposition in the pup. Thyroid hormones (TH) may be important modulators of these processes, and consequently we monitored circulating levels of free and total thyroxine (T_4) and triiodothyronine (T_3), and reverse-T_3 in 9 free-living female harbor seals (Phoca vitulina) and their pups for up to 25 days after birth. Neonatal levels of all hormones were significantly ($p<0.01$) higher in the pups than in their mothers, decreasing progressively to maternal levels by the end of lactation. Particularly high concentrations of rT_3 in the pups suggest inactivation of TH, allowing deposition rather than consumption of maternally-derived energy. Low free hormone levels in the mothers early in lactation may reflect elevated hormone-binding plasma proteins, and create a functional hypothyroid state. The findings highlight the role of endocrine systems in regulating metabolism through this critical period.

METHODS FOR ISOFLURANE INHALATION ANESTHESIA IN MARINE MAMMALS

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To enable multiple surgical procedures, 32 Steller sea lions, Eumetopias jubatus , were anesthetized in field conditions with isoflurane anesthesia after telazol® (tiletamine HCL and zolazepam HCL) restraint. Eumetopias adult females and sub-adults were carefully darted from rookeries with Telazol 1.8 to 2.5 mg/kg and either briefly masked or directly intubated with 20 mm Cole equine endotracheal tubes. After intubation they were attached to a large animal anesthesia machine and maintained on approximately 0.5 % isoflurane. 115 California Sea Lion pups, Zalophus Californianus, were captured by hand and anesthetized with isoflurane alone. The anesthetic equipment assembled was durable and easily transported by air, boat or backpack. Brass Ohio Kinetometer circuit and Fluotech II vaporizer stood up well to brutal shore landings and miscellaneous transport methods. The vaporizer was kept warm by sodium acetate catalytic hand-warmers in an insulated enclosure. Oxygen was transported by transfilling spun aluminum "E" cylinders and metered by a rugged dial pressure regulator. Monitoring included battery powered pulse oximetry, electrocardiograph (EKG) and electronic temperature probe and careful evaluation of physical signs including head movement, jaw tone, palpebral reflex and capillary refill. Periods of anesthesia ranged from 20 minutes to three hours. Masking pups only required three to four deep breaths for induction and .75 to 1.5 % isoflurane for maintenance. Zalophus pups recovered from anesthesia and extubated in one to three minutes. All pups were walking in seven minutes. Eumetopias recovery after 180 minutes of anesthesia was back to a telazol character patient which could be safely left on the rock where darted and supervised till awake. Extubation was in six to eight minutes, and significant head and neck movement occurred at 20 minutes or less. Shoulder or full body movement usually occurred at 30 to 60 minutes. Five animals died of darting complications. No complications or deaths were experienced due to volatile vapor anesthesia in this series.

WHY ARE MALE *ORCINUS* AND *GLOBICEPHALA* "MAMA'S BOYS"?

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Mating strategies of male mammals are designed to maximize the number of matings by adapting to the distribution of receptive females, with most juvenile males dispersing from natal groups to search out non-incestuous mating opportunities. In order to guarantee paternity, males attempt to control mating access to one or more females through male-male competition, resulting in a polygynous system. In contrast to this typical mammalian system of male dispersal and polygyny, recent studies of killer whales (*Orcinus orca*) and pilot whales (*Globicephala* spp.) have provided evidence that males remain with related females in natal groups into adulthood, and are not the fathers of the pod's calves. Our studies of social organization in *Orcinus* and *G.macrorhynchus* suggest that mating could be occurring in temporary associations between males and females from different pods. Why would males continue to live with mothers and sisters, instead of leaving in search of mates? We propose that this system could evolve when males are unable to control mating access to females, and promiscuous matings lead to paternity uncertainty. A male may have a greater liklihood of being related to known uterine kin (e.g. sisters' offspring) than to the offspring of females with whom he mates. Thus, kin selection through inclusive fitness could be the motivating factor for remaining with uterine kin. Males could benefit from improved access to resources in a kin-based, cooperative society, and may benefit the pod through group defence and allopaternal care of siblings and sister's offspring, as reported for male *Orcinus* in the Pacific Northwest and Norway and for *Globicephala* by our own observations of stable male-calf associations. This system is similar to human *avunculate* societies, where wealth is inherited from the uncle, or mother's brother. Paternity studies are still needed for these genera.

REGIONAL VARIATION IN THE EFFECTS OF EL NIÑO ON CALIFORNIA SEA LIONS

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El Niño (ENSO) events are known to have severe negative consequences for pinnipeds in the eastern Pacific. Changes in oceanographic circulation can reduce prey availability and thus pups production and adult survivorship. These effects typically increase with deceasing latitude, but previous studies from the southern Gulf of California (Baja, Mexico) suggested that local oceanographic parameters buffered California sea lion *(Zalophus californianus)* populations from the expected effects of the 1983 ENSO. Our data indicate that the buffering effects extended up to the central Gulf during the 1992 ENSO. The proportion of time spent at 18 activities (e.g., suckling, patrolling, etc.) by sea lions at I. Angel de la Guarda (IAG) did not differ significantly between the 1992 ENSO vs. normal years. The numbers of pups and adult females decreased during the ENSO, but the differences were not significant. At los Islotes (southern Gulf) 1992 pup production and growth were normal and female fecundity was higher than average. These data support the hypothesis that tidal mixing maintains adequate nutrient levels to buffer the Gulf from the ENSO effects seen in adjacent Pacific waters. However, the reproductive failure of some Gulf seabird populations in 1992 suggests that the buffering effects may not extend to all vertebrates, especially shallow divers. Also, the low numbers of sea lions at IAG in June 1993 may indicate a delayed ENSO effect there. California sea lions are known to migrate to some degree between the Gulf and the Pacific. As migratory patterns may vary during ENSO years, an accurate assessment of ENSO effects on the overall population requires assessment of sea lion numbers and productivity in both regions.

USE OF TEMPERATURE TELEMETRY TO DETECT AND MEASURE MILK INTAKE IN HARBOUR SEALS (*Phoca vitulina*)

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The applicability of using stomach temperature telemetry as a tool for detecting and measuring milk intake throughout lactation was investigated in harbour seals (*Phoca vitulina*), for possible application to a variety of marine and terrestrial species. Observations of a mother-pup pair were conducted daily as profiles of stomach temperature were continually logged. Milk intake was found to cause a decrease in pup stomach temperature, the recovery of which was related to the length of the nursing bout ($r^2 = 0.823$, $F_{(1,15)} = 69.91$, $p < 0.001$). The estimated milk intake per bout was found to increase, as a weekly average, with pup age ($F_{(3,68)} = 11.41$, $p < 0.0001$) over the 36 day lactation period. A diel shift in nursing time was noted, with a reversal from largely nocturnal to daytime feedings. Stomach temperature data collected from the mother provided conclusive evidence of seawater ingestion in harbour seals. Stomach temperature telemetry proved to be a reliable technique for detecting ingestion events in harbour seals, and could provide a valuable tool for investigating lactation energetics and aspects of maternal investment in a variety of species.

HABITAT USE OF PILOT WHALES AND OTHER CETACEANS IN THE CANARY ISLANDS

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Cetacean surveys to examine relationships between behavior and environmental parameters were conducted in the western Canary Islands between 10/89 and 4/92, first as part of an intensive study of pilot whale social organization, and later during week-long whale-watching expeditions aboard a 65' gaff-rigged ketch. Surveys ranged from 27°34.40'N to 28°59.56'N, and 15°42.20'W to 18°51.20'W, encompassing the islands of Tenerife, Gomera, Hierro, Gran Canaria and La Palma. GPS and compass triangulation location records were plotted on a map overlaid with 2 km square quadrats. Each quadrat was characterized by average depth (max. depth - min. depth/2) and a Contour Index (CI = 100*(max. depth - min. depth)/max. depth). *Globicephala macrorhynchus, Tursiops truncatus, Delphinus delphis, Grampus griseus, Stenella frontalis, Steno bredanensis* and *Ziphius cavirostrus* were identified. *Globicephala* were found exclusively off southwest Tenerife (mean average depth = 1386m and mean CI = 34.0), preferring steep slopes along the 1000 m depth contour in a submarine canyon which drops off to almost 3000 m deep. When alone, rest was the most common pilot whale behaviour but in mixed groups, feeding and travel were the most prevalent. *Tursiops* were found throughout the survey area, commonly close to the south shore of Gomera, but also offshore in association with *Globicephala* pods. When alone, feeding and travel accounted for the majority of *Tursiops* time. *Delphinus* were only observed in deep water from January through May. Remaining species were sporadic visitors with few sightings. Maps clearly show range preferences and data suggest species-specific patterns of habitat use amongst a diversity and abundance of cetaceans. Dedicated censusing could better investigate the larger question of resource partitioning in *Cetacea*.

OBJECT CONSTANCY IN DOLPHIN ECHOLOCATION

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We examined the question of how dolphins represent objects they experience with echolocation. Dolphins may construct some sort of aspect-independent cognitive representation that contains structural (eg, shape) information. In contrast, they may form representations based upon acoustic features of the echoes from the objects. Consistent with the structural hypothesis, the acoustic structure of echoes from *aspect-dependent objects* (eg, cubes) does not necessarily map onto the 3-D structure of the objects isomorphically. If dolphins were to represent directly the acoustic structure of echoes, then they could have problems recognizing aspect-dependent objects at different orientations because of the lack of 1:1 correspondence between changes in the object's orientation and the resulting changes in the echoes.

A blindfolded Atlantic bottlenosed dolphin (*Turslops truncatus*) was asked to discriminate using echolocation among a set of aspect-dependent geometric solids that were free to rotate. Thus, the dolphin was given the opportunity to learn about the invariant characteristics of object identity across changes in echoes. Each echo train was recorded and an Integrator Gateway neural network (IGN) was trained to discriminate the objects using frequency information contained in the echo spectra.

The dolphin and the IGN were able to recognize the geometric objects even though orientation was free to vary, thus demonstrating object constancy. Good object classification by the IGN indicated that whole echo spectra contained sufficient information for object recognition across changes in orientation. The results were interpreted as evidence for the formation of aspect-independent representations that contain more than simple acoustic features of the echoes from the objects.

THE FUNCTION OF BEHAVIOR AND VOCALIZATIONS IN MALE COALITIONS OF FREE-RANGING ATLANTIC SPOTTED DOLPHINS, STENELLA FRONTALIS.

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Free-ranging Atlantic spotted dolphins, Stenella frontalis, were observed in Bahamian waters from 1985 -1993. Underwater video with sound was used to correlate sound and behavior, and ID individuals. Male spotted dolphins form associations with each other as juveniles through affiliative signals and socio/sexual play and practice their communication signals and synchronized behavior as they mature. Functions of male coalitions include team foraging, cooperation during courtship with females, monitoring and intervening during the escalation of aggression, and defense against intruders such as other spotteds or bottlenose dolphins, Tursiops truncatus. Older adult male spotteds take an active role as teachers of younger males, possibly as a way to gain access to females who are sexually mature. Male bottlenose and spotteds also engage in regular socio/sexual behavior in the wild. This interspecific behavior may function to solidify mixed species coalitions that engage in cooperative foraging and intruder repulsion of conspecifics.

MILK INTAKE OF AUSTRALIAN SEA LION PUPS

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Female sea lions face the problem of balancing the time required to forage at sea with the time necessary to feed their pups ashore. How much milk is transferred per shore visit and how this changes over time is part of the maternal strategy and varies among species.

Milk intake of Australian sea lion (*Neophoca cinerea*) pups was measured at Seal Bay, Kangaroo Island, South Australia, during April, 1987. Milk ingestion was estimated from total body water influx using tritiated water and ^{18}O. Mean milk consumption for 15 pups was 1.16 l/d ($\bar{x}$ age = 80 days; $\bar{x}$ mass = 17.6 kg). Milk intake ranged from 0.52-1.82 l/d and was more strongly correlated with pup mass than with age. Milk intake per day increased as a function of pup mass. Milk transfer per day was less for females with longer shore visits, and length of shore visits were shorter for females with bigger pups. Mean milk intake per shore visit was 3.93 $\pm$ 1.14 l ($\bar{x}$ visit = 37.2 $\pm$ 12.7 h) and increased with pup mass.

Increased suckling efficiency of pups appears to enable female Australian sea lions to limit their stays ashore without compromising pup growth.

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PLASTINATION, SPECIMEN PRESERVATION FOR THE 21ST CENTURY.

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PLASTINATION is the impregnation of biological or porous materials with a curable polymer. This technique removes tissue fluids and some lipids. Using the differences in vapor pressure, the polymer is drawn into the dehydrated tissue. The plastination process was invented in 1975 by a physician, anatomist, Dr. Gunther von Hagens, Heidelberg, Germany. The polymers and the process are patented; however, use for teaching has only minor restrictions and is encouraged. The silicone polymer is the most widely used of several polymers. The silicone technique is used in four basic steps. The specimen is first prepared to demonstrate the desired detail, fixed for a short period of time in a low concentration (1 - 10%) of buffered formalin or other preferred fixative solution and then washed using running water to prepare the specimen for dehydration. The specimen is dehydrated in cold (-25°C) acetone. Acetone serves as a volatile intermediary solvent, necessary for impregnation of the specimen with the liquid plastic. Ethanol may be used as a dehydrant, but the specimen must be saturated with acetone or dichloromethane before impregnation. Impregnation occurs in a vacuum chamber at -25°C. The dehydrated specimen is submerged in the viscous silicone polymer and the vacuum is reduced one atmosphere over a period of 3 - 5 weeks. After draining off the excess polymer, the impregnated specimen is exposed to a curing (polymerizing) agent. The finished product is a noninfectious, odorless, dry to touch, and nontoxic specimen. The specimen maintains its original shape and some consistency and may be stored at room temperature indefinitely.

In addition to normal anatomical specimens, plastination allows for long term preservation of unusual or rare specimens, such as non-domestic animal specimens, rare pathological specimens or specimens with anomalies. The University of Tennessee has used the plastination technique since 1984. As marine mammal specimens have become available, we have begun to preserve them via this process. This is a unique opportunity to build a library of useful marine mammal anatomical and pathological specimens which will be used for education and research. Specimens from zoos and aquaria as well as stranding networks are being utilized to build this marine mammal collection.

HOW DISTINCT ARE RESIDENT AND TRANSIENT KILLER WHALES?

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Based on studies off the Pacific Northwest, the existence of two sympatric forms of killer whales (residents and transients) that differ in their morphology, ecology, and behavior has been proposed. Some accounts have suggested that these two forms represent different races, incipient species, or even different species. We test the hypothesis that these two forms of killer whales differ significantly from each other. The data used to test the discreetness of each character are obtained from the literature and unpublished sources. We conclude that some differences exist between these two forms of killer whales in the Pacific Northwest. However, most of these differences are relative, not absolute, in nature. Most of the characters that differentiate the two forms are behavioral. It is likely that these behavioral characters are learned and thus may not have a strong genetic component to them. Such cultural differences are documented in other groups of highly social mammals. The differences between average group size for the two forms is not as great as implied in the literature and when the residents are separated into their respective communities, there is no clear distinction between the two forms. The characters that are genetically defined are fin shape, saddle patch, and mDNA. The slight morphological differences may be the result of genetic similarity among individuals within extended family groups that exhibit limited out-breeding, and probably not diagnostic for larger populations. Preliminary results from mDNA sequences suggest that the two forms are somewhat genetically distinct. More research, especially genetic studies, are needed to better understand these differences.

MOVEMENTS OF MALE PACIFIC WALRUSES (*ODOBENUS ROSMARUS DIVERGENS*) IN BRISTOL BAY, ALASKA IN SUMMER

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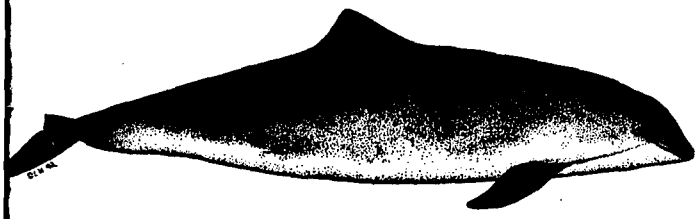
Satellite-linked radio transmitters (Platform Transmitter Terminals, PTTs) with saltwater switches (SWS) were deployed on 11 adult male Pacific walruses in Bristol Bay in 1987, 1988, and 1990 to indicate individual haulout patterns and locations in summer. For all PTTs combined, the SWS was in the water 70% of the sampling periods. When walruses were hauled out they were mostly on beaches at Round Island or Cape Peirce or resting at sea in one consistent area. Walruses with transmitters showed 2 patterns of behavior: a "classic" pattern of 2-4 da at the haulout, followed by 7-10 da at sea, then return to the haulout; and a "daily" pattern of remaining on the haulout with short daily trips to sea. Only for walruses with the daily pattern was the proportion of time hauled out correlated to time of day (X^2 tests, $p < 0.01$). Time hauled out was different among months ($X^2 = 54.315$, $df = 4$, $p = 0.0001$); several walruses changed behavior patterns from classic to daily during July. The proportion of the walruses with PTTs hauled out at Round Island was positively correlated both with the number of walruses hauled out on the main eastern beaches at Round Island and on all Round Island beaches. The proportion of walruses with PTTs that were hauled out was 0.44 $\pm$ 0.21 over all days, 0.54 $\pm$ 0.26 for peak haulout days, and 0.55 $\pm$ 0.18 for peak periods (peak haulout day plus 1 day before and 1 day after). Satellite transmitter locations were estimated when the walruses were at sea. When walruses exhibited the classic pattern, most of the at-sea locations were approximately 100 km south of Round Island in the region bounded by 57.5° - 58.5° N. latitude and 159.5° - 160.5° W. longitude. This area may be a resting area (an at-sea analog of Round Island) or a feeding and resting area.



BIOLOGICAL AND ENVIRONMENTAL HABITAT FACTORS FOR MARINE MAMMAL SPECIES CAUGHT IN THE NORTH PACIFIC DRIFTNET FISHERIES FOR SQUID.

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Habitat requirements for northern right whale dolphin, *Lissodelphis borealis*, Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, Dall's porpoise, *Phocoenoides dalli*, and northern fur seal, *Callorhinus ursinus* are identified via canonical correlation analysis comparing bycatch data for the high seas driftnet fisheries of the North Pacific and sighting survey data with associated biological and environmental data. Biological data include gut content analysis, other catch species, sighting surveys and midwater trawl samples from research cruises. Environmental data include data collected with each net observation, satellite images and ship of opportunity data. Canonical correlation analysis identifies the intervals within a set of a continuous variables that is associated with the presence of individuals and estimates the probability that individuals are present for specific habitats within these ranges. Preferred habitats are those with a relatively high probability of having individuals present.

THE NORTHERN ELEPHANT SEAL IN OREGON: AN EXPANSION OF THE BREEDING RANGE AND A PATTERN OF REGULAR ONSHORE OCCURRENCE.

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In 1993, northern elephant seals (Mirounga angustirostris) gave birth to three pups at Shell Island, Cape Arago, Oregon (43° 18' 45" N 124° 24' 5" W), 600 km north of the closest established breeding site. All of the pups survived to weaning age but two where washed from the beach by heavy surf and high spring tides soon after weaning, and were not seen again.

The pattern of colonization of Shell Island by elephant seals mirrors that observed at other newly established breeding sites. Elephant seals have regularly come onshore here for the past ~15 years, with peak numbers occurring during April - June and September - November. Of the tagged seals seen at Shell Island 95% were from Año Nuevo or the Farallon Islands, the closest breeding sites to the south. All tagged seals observed at Shell Island were less than 5 years of age.

Shell Island is the only site in Oregon that is regularly visited by elephant seals. Young animals, less than 2 years old, come onshore at other sites in Oregon to moult but do not occur with any repeatability. There are no other outer coast locations in Oregon where northern elephant seals could form successful breeding colonies; there are no large islands within the state with beaches that are immune from high tide or winter storm surge. The colonization of Shell Island represents an expansion outside of the northern elephant seal's historical breeding range, but because of habitat limitation this site will only support a small colony of seals with a variable breeding success that will be highly weather dependent.

SWIMMING SPEED AND DIVING BEHAVIOUR OF ADULT FEMALE SOUTHERN ELEPHANT SEALS

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Swimming speed was measured for two adult female southern elephant seals during their post-breeding dispersal from Macquarie Island. Swimming speed was measured by a paddle wheel incorporated into a custom made time depth recorder. Depth and swimming speed were recorded simultaneously every ten seconds to allow changes in swimming behaviour to be related to the progress of the dive. It is concluded that swimming speed adds valuable extra information to standard dive data that can be used to help interpret the behaviour of the animals during different dive types. Dives with simple "U" shaped depth profiles exhibited bursts of rapid swimming during the early descent phase of the dive. Swimming speed was relatively constant for the remainder of the dive. Swimming speed also varied considerably during the "wiggle" component of flat-bottomed dives, perhaps indicative of pursuit and prey handling. The recorders also registered zero velocity during the slow descent phase of "rest dives", indicating that the animals had stopped swimming and were slowly sinking due to their negative buoyancy.

REGULATION OF DIVING RESPONSE IN SEALS: ROLES OF CATECHOLAMINES AND OTHER HORMONES

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Following the advent (in 1982 and 1983) of microcomputer assisted monitoring of the physiology and biochemistry of Weddell seals during voluntary diving at sea, the data base from similar field studies of this and other species has literally exploded. However, there has remained a disturbing and total lack of detailed endocrinological information during voluntary diving. Accordingly, we set up a standard 'one computer carrying seal - one breathing hole' arrangement for monitoring through rest, diving, and recovery cycles (i) plasma catecholamines, insulin, glucagon, thyroxine, cortisol, and antinatriuretic hormone titres, (ii) plasma metabolites, (iii) myoglobin saturation of a locomotory muscle, (iv) blood hemoglobin concentration and hematocrit, and (v) relative spleen volume by means of ultrasound imaging. Dive duration, dive speed, and heart rates were also routinely monitored. Catecholamine (especially epinephrine and norepinephrine) concentrations increased during diving, in long and short dives. Plasma lactate concentrations correlated with dive duration and with catecholamine concentrations; this correlation was most notable at high [lactate]. [Epinephrine] also correlated with with high [Hb] and hematocrit values (with spleen contraction). The results suggest crucial roles for the catecholamines in regulation of (i) spleen contraction, (ii) peripheral vasoconstriction, (iii) fuel preferences, & (iv) anaerobic contribution to energy requirements. Additionally, changes in plasma [glucose] seemed mediated by insulin. Supported by NSF and NSERC (Canada).

Increased Morphological Variation and Asymmetry in the Northern Elephant Seal Following an Extreme Population Bottleneck.

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The northern elephant seal (*Mirounga angustirostris*) was heavily exploited during the 19th century and reduced to a bottleneck population size of approximately 20 individuals. The population has now recovered to more than 100,000 seals. Such extreme demographic fluctuations have been shown to sometimes affect quantitative genetic variation in controlled experiments, such that morphological variation or fluctuating asymmetry increased following bottlenecks or inbreeding. We investigated morphometric and meristic measures on living seals (using the closely related southern elephant seal, *Mirounga leonina* as a control group), and morphometric variation in northern elephant seal skulls collected before and after the bottleneck. These data indicate that the bottleneck of about 20 seals was sufficient to alter the pattern of variation in a number of quantitative characters, increasing post-bottleneck variation and asymmetry. Ten out of 30 cranial characters showed a statistically significant increase in variation, and 1 significantly increased in asymmetry following the bottleneck. Although we are not aware of similar reports for other wild mammalian populations, the introduction of novel variation in this way could have important implications for the evolution and survival of these species following demographic fluctuations and periods of inbreeding.

THE FORM AND FUNCTION OF THE TENDONS OF THE PECTORAL FLIPPER IN THE ATLANTIC BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

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The pectoral limb of the Atlantic bottlenose dolphin (*Tursiops truncatus*) has retained the fundamental design of its creodont ancestor. At the same time, the pectoral limb has evolved many structural characteristics in response to the hydrodynamic constraints found in the dolphin's aquatic environment. In this study, the tendon system of the pectoral limb of *T. truncatus* was examined.

From the brachium distally, the *T. truncatus* humeral intrinsic muscles were replaced with tendons, resulting in an amuscular region extending distally from the diaphysis of the humerus to the digits. This tendon distribution represents a passive form system serving to restrain movement of the bones and results in the lack of movement in the joints distal to the scapulo-humeral joint. The tendons are described with respect to origins, insertions and direction of the majority of the fibers.

EFFECTS OF EL NIÑO ON MATERNAL ATTENDANCE PATTERNS AND PUP BEHAVIOR IN A DECLINING POPULATION OF STELLER SEA LIONS

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Maternal attendance patterns and pup behavior of the Steller sea lion (Eumetopias jubatus) were studied on Ano Nuevo Island, CA, during the 1992, 1983, and 1973 breeding seasons. The duration of periods at sea and periods present on the breeding area for lactating females, and pup activity budgets were compared between studies in order to investigate the combined effects of population decline and El Nino on these parameters. El Ninos of varying intensities occurred during all three years studied.

Females were identified from natural markings; their arrivals and departures from the study area were noted as they occurred between 700 and 2000 hours. Pup activity budgets were determined by hourly instantaneous scan samples. Pup behavior was classified into the categories low activity, high activity, resting, and suckling.

Female feeding cycles were longer in 1992 compared with 1973 and 1983. Pups also spent significantly less time suckling in 1992. A long-term decline in prey availability in combination with the 1992 El Nino event may be responsible for these differences. Since suckling times are correlated with milk intake in some otariid species, decreased amount of time spent suckling is possibly a result of a decline in milk production by females, also a result of prey decline.

DIVING PATTERNS OF SAIMAA RINGED SEAL (PHOCA HISPIDA SAIMENSIS NORDQ.)

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The diving patterns of 3 adult Saimaa ringed seals (landlocked subspecies living in Lake Saimaa, Finland) were examined during spring, summer and autumn by the use of VHF-transmitters. Over 10000 dives were registered. In different individuals the length of the dives and diving patterns differed somewhat. The mean length of dives seemed to increase from spring to autumn, e.g. in one individual the mean dive length increased from 6 min in June to 10,5 min in October. Clear periods of successive long dives (>12 min) were observed in two individuals. Longest dive meaured was 23 min. The duration of the long dive period was often over three hours (maximum 6 hours) and the mean length of the dives was about 15 min. These long dives are assumed to be sleeping dives. The surface period between active dives increased from 0.7 min after 5 min dive to 1 min after 12 min dive. Between sleeping dives the surface period is only about 0.8 min after 14 min dive but increases to 1.4 min after 22 min dive. These dives seem to be aerobic. The long dive periods occurred both at night and in the middle of the day. The seals also laid on rocky shore but after June only at night. The Saimaa ringed seal seem to have longer dives than the ringed seal of Northern Atlantic.

ECOLOGY AND OCEANOGRAPHY OF HARBOUR PORPOISE ENTRAPMENTS IN FISHING GEAR IN NEWFOUNDLAND AND LABRADOR.

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Harbour porpoise by-catch in gillnets may be a serious threat to this species throughout Newfoundland and Labrador where hundreds are caught each year. Foraging behaviour may underlie this vulnerability to entrapment by fixed gear since populations of harbour porpoise and commercially exploited fish occur concurrently.

We examined relationships between oceanographic and biological factors and by-catch near Cape St. Mary's, Newfoundland, a small fishing area where hundreds of harp seals, seabirds and harbour porpoise are caught each summer. Working with fishermen as they hauled their nets, we measured catch composition, including target and by-catch species, and environmental conditions such as bait abundance and conductivity/temperature profiles.

There are complex interactions between environmental and biological variables which appear related to the frequency of harbour porpoise catches. However, gillnet captures of harbour porpoise occur for a variety of reasons; present data do not warrant a conclusion that any single factor is primarily responsible.

ONTOGENY OF DIVING IN GALAPAGOS FUR SEALS

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The purpose of this study was the analysis of the development of diving in the Galapagos fur seal (*Arctocephalus galapagoensis*). *A. galapagoensis* is the smallest of all otariids and shows the longest period of dependency of offspring on maternal milk of any pinniped. Weaning occurs between the ages of 1 and 3 years. Dive behavior was monitored in 130 fur seals of various ages using electronic dive recorders. Small blood samples were analyzed for hematocrit and hemoglobin values. Maximum dive durations and dive depths increased from 0.8 min and 5.6 m for 6 month old animals to 4.47 min and 106.5 m for adult females (averages for age groups). Median values showed a lesser increase but larger variation, reflecting seasonal and lunar changes in prey accessibility. Blood values start at about 2/3 the level of adult females at birth and reach levels of adult females (Hct 48.6%, Hb 17.9 g/dl averages) at about 3/4 years. Animals younger than 1 year showed no consistent foraging activity. For older animals the aerobic dive limit (ADL) was extrapolated from moving sum plots of post dive intervals vs dive durations. This method was chosen to compensate for a possible delayed payoff of an oxygen debt incurred during anaerobic dives. The ADL appears in the moving sum plot as a disproportionate increase in minimum surface time values vs dive time. ADL values change from 1.3 min for yearlings (10.2 kg av.) to 3.3 min for adult females (28.5 kg av.). Foraging animals of all age classes showed distinct lunar cycles in activity patterns. The reduction in foraging activity during full moon, when prey of the deep scattering layer becomes less accessible, is much more pronounced in younger animals. This seems to be primarily an effect of low ADL values in young animals.

VOCAL RECOGNITION AMONG MOTHER-OFFSPRING PAIRS OF NORTHERN FUR SEALS.

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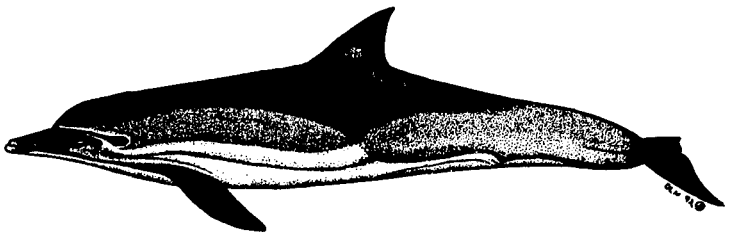
Animal recognition studies have relied heavily on species comparisons to indicate the sorts of evolutionary pressures shaping recognition behaviour. But these same sorts of pressures can vary within species. This is the focus of the present study: do mother-offspring pairs of northern fur seals (Callorhinus ursinus) recognize each other's vocalizations in the same manner and to the same degree? The structure of both female and pup vocalizations is sufficient for recognition although female calls may be better predictors of identity. Playback experiments indicate that pups recognize their mother's calls but the results are not as clear for females. These results are consistent with (1) behavioural observations showing that pups play the most active role in reunions, and (2) females may have a more difficult vocal recognition task to contend with than pups



ATLANTIC SPOTTED DOLPHINS OF THE BAHAMAS: IDENTIFICATIONS AND ENVIRONMENTAL AND SIGHTING CORRELATES FOR 1992 AND 1993

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Results from the 1992 and 1993 field seasons of Oceanic Society Expeditions' Project Dolphin are presented in two sections: individual identifications and sighting and environmental correlations. Data on the Atlantic spotted dolphin (*Stenella frontalis*) were collected during September and December 1992, and Spring - Summer 1993, underwater with a 35mm camera, two Hi-8 video cameras, and omni-directional hydrophones.

Relative age classes were assigned to individual dolphins based on the degree of spotting. There exists a resident population of approximately 80 spotted dolphins that inhabits the waters north of Grand Bahama Island. This estimate is low due to the exclusion of most very young spotted dolphins; these individuals possess no spots and usually no scars to facilitate reliable re-identification. We have positively identified 36 females and 25 males in this population.

We have recorded significant directionality of travel for individuals and groups, depending on time of day. However, sightings were not significantly correlated with particular time of day or season. Larger groups, of 5 to 20 dolphins, were observed more during sea state conditions of Beaufort 4 and 5 than in Beaufort 1 to 3. Encounter lengths were random by time of day. Severe storms appear to affect dolphin behavior, making them less willing to bowride and to socialize underwater with humans.

HOW STEREOTYPED IS THE SIGNATURE WHISTLE OF BOTTLENOSED DOLPHINS ?

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The signature whistle of the bottlenosed dolphin (*Tursiops truncatus*) is defined by its individual specificity, its predominance in a dolphin's vocalisation, and its high degree of stereotypy. An assessment of the latter usually depends on properties of the observer's gestalt perception. Although this is a valuable method to identify signature whistles, it does not allow an assessment of variability. In this paper the stereotypy of signature whistles has been investigated quantitatively in comparison to other whistle types. More than 1800 whistles produced by two individuals in various contexts have been analysed. Variability of single parameters of the fundamental frequency like duration, start and end frequency, and frequency range has been compared to cross correlation coefficients of whole whistle contours. Both methods confirmed that the signature whistle had the highest degree of stereotypy in the repertoire of an individual. Parameters of other whistle types had up to ten times higher coefficients of variance than those of signature whistles. However, the location of inflections in the signature contour had a two to three times lower coefficient of variance than its duration, range, or start and end frequency. Cross correlation coefficients supported in particular the result, that the shape of a given contour was more invariable than its degree of completeness or its duration.

HIGH LIPOPROTEIN LIPASE (LPL) ACTIVITY IN MOTHERS AND PUPS MAY ENABLE EFFICIENT MILK FAT TRANSFER IN GREY SEALS

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LPL regulates the hydrolysis of circulating triglyceride (TG) and the uptake of fatty acids (FA) by most tissues, including the mammary gland and adipose tissue. LPL is critical to the mother for secretion of the long-chain (LC) FA in milk and to the suckling infant in the assimilation of its high-fat diet. Phocid seals serve as excellent models in the study of LPL and fat transfer during lactation because mothers may fast completely while secreting large quantities of high fat milks and pups must digest and deposit large amounts of fat as blubber. We measured milk fat transfer by isotope dilution and post-heparin (PH, 100U/kg) LPL activity in 4 mother-pup pairs at birth and again late in the 16 d lactation period. Maternal PH-LPL was high and increased up to 10-fold by late lactation, which paralleled an increase in milk fat concentration (from 40% to 60%) and output (1.5 to 2.2 kg fat/d) over lactation ($P < 0.05$). Maternal plasma TG (during fasting) was inversely correlated to LPL activity ($P < 0.01$) and may be associated with the efficient incorporation of blubber LCFA into milk. In pups PH-LPL activity was already high at birth and increased with increasing total body fat content during lactation ($P < 0.05$). Although pup plasma TG increased with increasing daily fat intake ($P < 0.05$), pups efficiently cleared lipid from the circulation as evidenced by the direct incorporation into blubber of milk fatty acids and the high percentage (70% of intake) of fat deposited throughout lactation.

AN EDUCATIONAL PROGRAM FOR REDUCING WHALE HARASSMENT BY RECREATIONAL BOATERS

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Public interest in marine mammals is high and many opportunities exist for interactions. Whether such benevolent encounters are problematic is subject to debate, but probably varies by species and circumstance. An area of intense interaction exists in the area of the Stellwagen Bank National Marine Sanctuary (Massachusetts, USA), where approximately 25 commercial whale watch and numerous private vessels regularly close approach endangered humpback, finback and right whales. Regulation, other than the poorly defined prohibition on harassment is lacking. Although regional guidelines exist, they are inadequately disseminated and habitually violated.

In 1991, we initiated a direct, on-water education program targeting non-commercial boaters that approach whales. Our goal was to have boaters voluntarily increase their distance from whales. Using a 4m inflatable boat, we intercepted recreational boaters, discussed whale ecology, explained current laws, penalties and guidelines, and made suggestions for responsible whale watching. We also provided pamphlets showing photographs of ship struck whales and detailing appropriate and inappropriate methods for observing whales. Data on vessel distribution showed boaters increased their distance from whales following educational episodes. Repeat educational encounters with specific vessels was rare. This suggests either a long term impact or use of the area by transient boaters.

SURFACE AND DEEP LAYER PRODUCTIVITY: DO THESE FACTORS INFLUENCE SPERM WHALE (*PHYSETER MACROCEPHALUS*) DISTRIBUTION IN THE SOUTH PACIFIC?

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We investigated the importance of various factors influencing sperm whale distribution. The abundance of sperm whales was related to primary productivity, intensity of a deep scattering layer (300-600m), sea surface temperature (SST) and the depth of the thermocline, using data collected from a 40' sailing boat during a survey around the South Pacific (Panama-New-Zealand-Chile-Panama). Sperm whale abundance was determined by listening every half hour through an hydrophone for their characteristic clicks. The productivity of the upper layers was indicated by both a spectral radiometer and a Secchi disk. A sonar (Furuno CH14, 60 khz) was used to detect the deep scattering layer. The depth of the thermocline was measured with an expendable bathythermograph.

The spatial organization of the whales was highly clumped and most of the 74 encounters were found less than 80 miles from the previous one. These concentrations of whales were separated by 500-3000 nautical miles. However, the regions of concentration were not characterized by a higher surface productivity or a lower SST than adjacent waters, and no correlation was found between whale abundance and primary productivity, or SST, over any spatial scale. Only the presence and intensity of the deep scattering layer showed some correlation with whales distribution over scales broader than 500 n.miles. These results suggest that sperm whales are only dependant upon the productivity of the deeper layers and that there is little direct relationship between surface productivity and what's happening down deep.

BIOLOGY OF THE CLYMENE DOLPHIN (*Stenella clymene*) IN THE GULF OF MEXICO

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The biology of the clymene dolphin (*Stenella clymene*) was studied, based largely on 11 dolphins stranded along the Texas coast between 1981 and 1992 and six from a mass stranding in Florida in 1983. Five of the Texas dolphins were found alive; none lasted more than 4 days in captivity. There are year-round records from throughout the northern Gulf of Mexico; sightings have occurred almost exclusively in deep (> 200 m) offshore waters. A dark lateral stripe occurs on most animals. Males reach greater lengths than females, but there may be little sexual dimorphism in other external measurements. Length of the upper toothrow vs. preorbital width provides good separation of skulls of clymene, striped (*S. coeruleoalba*), and spinner (*S. longirostris*) dolphin adults; however, care must be taken to distinguish young striped dolphin skulls. External parasites include barnacles and whale lice, and internal parasites include *Phyllobothrium* sp., *Monorygma* sp., and *Nasitrema* sp. Some dolphins had as many as 31 bites and scars from cookie-cutter sharks (*Isistius brasiliensis*) on their bodies. Preliminary evidence indicates that females become sexually mature by 171 cm on average and males by 176 cm; there is a possible calving peak in the spring. Most herds observed at sea have been small (mean herd size = 32.2 individuals, n = 13), and bow-riding is common. Twenty whistles were recorded; their structure was similar to those of other species of the genus, with overall slightly higher frequencies.

COPPER IN LIVER, KIDNEY, AND MUSCLE OF BOTTLENOSE DOLPHIN (*Tursiops truncatus*) FROM THE INDIAN RIVER LAGOON SYSTEM, FLORIDA

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Copper concentration in liver decreases with increasing body length of the bottlenose dolphin, *Tursiops truncatus*, in animals recovered by the Southeastern U.S. Stranding Network from Florida's Indian River Lagoon system. The Indian River is a site known to have high levels of copper due to leaching from boat paint used by the large recreational boating population. This raises the question of the fate of copper in dolphin tissues. Copper concentrations in samples of liver, kidney, and muscle from nine dolphins were determined using flame absorbance spectrophotometry, and translated into copper concentrations per gram wet and dry weight tissue. Significant correlations ($p<.10$) existed between dolphin body length and copper concentrations in wet and dry liver, and wet kidney tissue. Copper concentration in muscle did not correlate with body length, and varied little among these specimens. Copper concentrations in liver, and to a lesser degree in kidney decrease with body length. These results suggest a transfer of copper from liver tissue to muscle as a dolphin grows, since muscle mass must increase during growth, yet copper concentrations remain stable. A preliminary conclusion is that mammalian muscle may serve as a biological sink for excess copper in the marine environment.

LEVELS OF PCBs AND DDTs IN SUCKLING GREY SEAL PUPS, AND THE POSSIBLE EFFECT OF PCB ON THYROID HORMONES

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In experiments on harbour seals (*Phoca vitulina*), it has been documented that animals fed fish containing high levels of PCBs had lower plasma-levels of thyroid hormones as compared to animals fed fish containing low levels of PCBs (1). To examine if the PCB-exposure experienced by suckling grey seal (*Halichoerus grypus*) pups at Froan, Norway, may affect their plasma-levels of thyroid hormones, concentrations of ΣPCB (sum of 22 PCB congeners) measured in bloodcells were correlated to the levels of triiodothyronine (T3), total thyroxine (TT4) and free thyroxine (FT4) in the plasma. Concentrations of DDTs (pp--DDE, op-DDD, pp-DDD, op-DDT and pp-DDT) in blood cells were also analyzed. Plasma concentrations of thyroid hormones were analyzed using RIA technique.

The concentrations of ΣPCB and ΣDDT in blood cells from suckling pups were 2819.6 (SD = 1897.6, n = 17) and 1982.3 ng/g lipid weight (l.w) (SD = 2013.8, n = 17), respectively. This is similar to mean values reported in blubber tissue of dead seal pups from the same area; 1070.7 ± 246.4 ng ΣPCB/g l.w. (n = 7), and 990.8 ± 400.1 ng ΣDDT /g l.w. (n = 7). The data indicate that the concentrations of ΣPCB and ΣDDT in neonatal pups at Froan are lower as compared to concentrations reported in blood of grey seal pups from the Northwest Atlantic (2). Although the two pups that had the highest ΣPCB concentrations also had the lowest plasma concentrations of thyroxine, there was no significant correlation between the ΣPCB concentration in blood cells and the corresponding plasma concentrations of any of the thyroid hormones in the suckling pups.

1. Brouwer *et al.*, *Aquatic Toxicol.* **15**, 99-106 (1989).
2. Addison & Brodie, *J. Fish. Res. Board Can.* **34**, 937-941 (1977).

DESCRIPTION OF THE BEHAVIORAL PATTERNS OF THE HUMPBACK WHALES (Megaptera novaeangliae), cows and calves pair in the Bahía de Banderas, México.

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The objetive of this work is to show the ethogram obtained for the humpback whale's females and calves pairs during their 1992 breeding season at the Bahía de Banderas, Nayarit-Jalisco, México. Relation between behavioral patterns and enviroment conditions were done, showing that the main perturbing factor was the boat traffic withing the human activities, increasing the interference swimming, evasive behavior and changes in the displacement directions.
Ninetheen behavioral patterns were obtained, the most common were true breach, flippering, flukes, evasive behavior and displacement calf aside.

Are described five new behavioral patterns belonging to the epimeletic and undefined function categories, those are watchfulness, interference swimming, evasive behavior in the first case, half dorsal flop and lateral desplacement for the second category.

ANNUAL REPRODUCTIVE CYCLE OF THE FEMALE HAWAIIAN MONK SEAL

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The annual reproductive cycle of the female Hawaiian monk seal (Monachus schauinslandi) is described from data collected at Laysan Island (1982-1991) and Lisianski Island (1982-1983) in the Northwestern Hawaiian Islands. Pupping, lactation, weaning, and molting were directly observed. Because mating was rarely observed, it was inferred from mounting injuries and the proportion of females attended by adult males. Pooled birth rates were 0.544 for all adult-sized females and 0.675 for females parous in earlier years. For parturient females, pupping peaked in late March and early April, weaning in May, mounting injuries in May and June, and molting in July. The median mounting injury and molting dates for nonparturient females occurred 17 and 28 days earlier. Pupping date set the timing of subsequent events in the annual cycle, but this timing was adjusted by loss of the pup or poor physical condition. The interval from presumed mating to next birth was approximately 11 mo, which is consistent with other seal species. Individual pupping patterns varied widely. The mean interval between births in consecutive years was 381 days; females that pupped in consecutive years gave birth later each season. Conversely, females who skipped a year or more gave birth earlier their next pupping season. This variation from a true annual cycle may explain the protracted breeding season and skewed pupping distribution observed in this study.

CETACEAN SIGHTING RATE ESTIMATES FOR THE OFFSHORE WATERS OF THE U.S GULF OF MEXICO

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Shipboard surveys were conducted in the spring of 1990-1992 to estimate the abundance of cetaceans in the offshore waters of the U.S. Gulf of Mexico. The survey area encompassed the waters from about the 100 m depth contour line to the limit of the Exclusive Economic Zone (about 370 km offshore). A total of 13042 km of trackline was searched over a period of about 90 at-sea-days. Paired high-powered binoculars were used to detect cetaceans along the survey track. Data was collected for line-transect analysis, and 423 groups of cetaceans were sighted during on-effort surveying. Sighting rates (sightings/km) for cetaceans in the northern Gulf of Mexico were as follows: all cetaceans (0.0324), baleen whales (0.0005), Physeter macrocephalus (0.0022), Kogia whales (0.0034), beaked whales (0.0008), delphinid whales (0.0041), Stenella dolphins (0.0086), Stenella attenuata (0.0057), and Tursiops truncatus (0.0053).

A NEW ROLE FOR THE DEPARTMENT OF THE NAVY IN WEST INDIAN MANATEE PROTECTION AND MANAGEMENT

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The Department of Defence is currently funding several natural resource projects to benefit marine mammals through the DOD Legacy Resource Management Program. The Program was created by the Department of Defence Appropriation Act of 1991, to enhance and expand the existing stewardship of DOD lands. To meet the purposes of the Act, the Program has funded activities through its natural/cultural resources programs on military installations. More than 400 demonstration projects in 43 states, the District of Columbia, and 6 territories have been initiated as of 1992, with total funding at $35 million. The Program is allowing DOD to move beyond regulatory compliance into active protection and management. The Navy has sponsored three demonstration projects involving the West Indian Manatee (Trichechus manatus): one at Naval Station Roosevelt Roads in Puerto Rico, one at Naval Air Station Jacksonville in Florida, and one at Naval Submarine Base Kings Bay. The goals of the three projects have encompassed species and habitat protection, education, and research. Results include three refuge areas, two interpretive viewing areas, partial funding/support of a satellite telemetry project, and design/installation of manatee propeller guards. All three projects have been in partnership with multiple agencies and conservation groups. Cooperative partnerships have been a hallmark of the Program, and have allowed these and other marine mammal projects to be designed and proceed using the best scientific, technical, management, and legal expertise.

ECOLOGY AND BEHAVIOUR OF HUMPBACK DOLPHINS *SOUSA CHINENSIS* OF EASTERN CAPE, SOUTH AFRICA.

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Photo-identification surveys between April 1991 and May 1993 were conducted to determine the distribution, movement, abundance and behaviour of humpback dolphins in Algoa Bay and St. Francis Bay, Eastern Cape, South Africa.

A total of 73 (87.7%) of all individuals seen were identified and catalogued using marks, scars and pigmentation patterns on the dorsal fin, hump and back. Thirty one (42.5%) of these were seen once only, 26 (35.6%) more then once but less then four times, while the reminder were resighted four times or more. The most frequently sighted dolphins were occasionally not seen for periods up to 6 months and often moved great distances, sometimes more than 110 km in 2 days. However these were also often seen repeatedly in the same areas. These data suggest that most dolphins were transient while others form semi-resident groups which use the surveyed area regularly, but not exclusively. Semi-resident animals were mostly adults (75%), of which 66.7% were females. Most transient animals were adults (61.4%), but few of these (2.8%) were females.

Low coefficient of association index between adults and unstable school composition suggests that these dolphins form highly dynamic social units. Though strong affiliations were observed between "probable mothers" and their calves.

Activity was related to time of day, allowing a description of daylight activity budgets. Peak activity was noted in the morning, followed occasionally by a secondary peak in the afternoon. The main daylight activity was feeding and other activities were directly effected by this. The proportion of time spent feeding varied, however, with area, as did time spent on travelling, playing or resting. No seasonal differences in the behaviour of dolphins was observed.

SOUND DETECTION THRESHOLD DETERMINATION IN TWO CALIFORNIA SEA LIONS AND A HARBOR SEAL

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Noise from human activities both in air and underwater has the potential to influence the behavior of marine mammals. In order to understand the possible effects of anthropogenic sound on pinnipeds, we are conducting experiments to determine pure tone detection thresholds, especially at low frequencies (under 500 Hz), of a harbor seal (Phoca vitulina) and two California sea lions (Zalophus californianus). Two of the animals (one Zalophus and the Phoca) have been trained to wear custom-fitted headphones in order to determine minimum audible sound pressure levels at or near the tympanic membrane. The third animal (Zalophus) is being directly trained to respond to underwater reverberant sound fields of various frequencies (100-1000 Hz) at a depth of approximately 1.5 m. Preliminary results suggest that both species hear much better at low frequencies than previously expected. Implications for effects of man-made noise on both the in-air and underwater activities of pinnipeds are discussed.

CONTEMPORANEOUS STRANDINGS OF BOTTLENOSE DOLPHINS ALONG THE TEXAS COAST

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A decade of stranding data from the Texas coast was analyzed for contemporaneous patterns. From Nov. 24, 1980, through Dec. 31, 1990, there are records of 899 bottlenose dolphin strandings along the coast of Texas. A scatter-plot of 859 of these strandings (40 were unknown/unreadable locations) is consistent with previously reported geographic and seasonal patterns. Another pattern subtly evident is geographic clustering of single strandings over short-term periods. A method was developed to identify stranded individuals associated with contemporaneous stranding events (CSEs). Groups of 3 or more dolphins were tested against a random-distribution model at $p<0.0005$ level. 154 dolphins (17.9%) were involved in twenty-six CSEs. There were 22 CSEs (mean number of dolphins = 5.6, range = 3-21) on gulf beaches and 4 CSEs (mean = 7.8, range = 3-23) in bay systems. It is recommended that stranding coordinators be observant for CSEs, and evaluate CSE individual animals for similar physical/physiological conditions that may suggest a common cause of mortality.

DIVING BEHAVIOUR OF A SUBADULT MALE GREY SEAL (*HALICHOERUS GRYPUS*) IN THE BALTIC SEA.

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As a part of larger study (Sjöberg et al. in this volume), data from a satellite tagged subadult male grey seal (*Halichoerus grypus*)in the Baltic Sea, was used to distinguish different dive types. The data from this SMRU satellite data logger is different from data from a TDR. It uses data from submergence and depth sensors to produce surface / dive duration, dive depth, swimming velocity and haulout duration data. All dives are divided in five sections, based on dive duration, with depth and mean swimming velocity recorded for all sections of the dive. For all dives the maximum depth is recorded.

We found four different dive types among the 3561 recorded dives: type A-dives (square shaped dives, with flat bottom, descent and ascent angle of the same size), type B-dives (v shaped dives, with descent and ascent angle of the same size and an index of dive squareness less than 0.7), type C-dives (dives with shallow descent angle, partly flat bottom and steep ascent angle) and type D-dives (dives with steep descent angle, partly flat bottom and shallow ascent angle).

The frequency of dive types showed a diurnal variation which was correlated to the seals haulout, which normally occurs at night time (Sjöberg et al. in this volume), and there was diurnal variation in both dive duration and dive depth. Dives had a longer duration and were shallower at night, while during the day they were shorter and deeper. This suggests that many of the dives at night are rest dives close to the haulout area and many of the dives in daytime are transport and foraging dives. Usually haulout patterns are affected by tide movements. However that is not the case in the Baltic, while there is no tide.

BODY SURFACE TEMPERATURE IN A HARBOUR PORPOISE (Phocoena phocoena)

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The risk of hypothermia is high for small cetaceans because of their high body surface to volume ratio. To compensate for this, Harbour porpoises have a relatively thick blubber layer. The less insulated appendages can be used to dissipate heat during activity. For this study, a stranded juvenile Harbour porpoise, which was under treatment at the rehabilitation centre of the Harderwijk Marine Mammal Park, was taken from the water to measure its body surface temperatures with an infra-red heat gun. Compared to other body parts, the temperatures of the tongue, eyes and genital slit were high. The temperatures of the blowhole, skin between pectoral fins, the dorsal skin rostral of dorsal fin, umbilicus and tailstock were around the average body surface temperature. The temperatures of the the pectoral fins were low compared to all other measured body parts and remained low even after 10 min. out of the water. The temperatures of the dorsal fin and tail-fluke were low compared to most body parts when the animal had recently left the water, but increased over time. The study also investigated symmetry in body surface temperature.

MARINE MAMMALS AND BOATS IN HERVEY BAY MARINE PARK, QUEENSLAND, AUSTRALIA, AS DETERMINED BY AERIAL SURVEYS.

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Aerial surveys were conducted in Hervey Bay Marine Park (Queensland, Australia) to document presence of marine mammals and boats from August 11 - October 24, 1993. Hervey Bay is located between Fraser Island and the eastern coastline of Australia approximately 300 km north of Brisbane.

A total of 75 hours was logged during 19 flights from August 11 through October 24, 1992. 186 pods containing an estimated 317 humpback whales were observed during 41.5 hours of census effort across 17 flights (with a mean observation rate of 4.48 pods per hour, ranging from 0.0 to 7.75, STD = 2.07). In addition, 476 dolphins sightings (including an estimated 2626 animals), 182 dugong sightings (with an estimated 194 animals) and 392 boats observations were made.

Humpback whales traveled south past Fraser Island on their way back to the Antarctic after wintering on the Great Barrier Reef. As the season progressed, a larger proportion of the whales moving south came into the Bay, remaining for two to three days. The general size and composition of pods suggested that Platypus Bay, in the northeastern part of the Park, may be an important resting area for mothers and their calves.

A variety of dolphin species were observed to be widely distributed throughout the park. Dugongs were observed in areas not thought to be part of their normal range, perhaps due to destruction of seagrass beds by inordinate flooding earlier in the year. Boat distribution was primarily determined by location of whales. A tendency for boats to travel in "packs", and a frequent lack of understanding of Park Regulations shown by visiting private boaters, were also noted as issues requiring attention by Park management.

ANOMALOUS DISTRIBUTIONS OF RIGHT WHALES (*Eubalaena glacialis*) IN THE GULF OF MAINE IN 1992: AN EFFECT OF GLOBAL-SCALE CHANGES

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For the first time since 1979, no right whales were sighted in 1992 during late spring/early summer aerial surveys in the Great South Channel (GSC) region east of Cape Cod and Nantucket, Massachusetts. Additional aerial surveys were conducted over much of the Gulf of Maine in an attempt to locate any other concentrations of right whales. During the season when right whales would normally be expected in the GSC, a few were sighted in the central Gulf of Maine, none were found in their normal late summer/fall habitats in the Bay of Fundy and south of Nova Scotia, and a few remained resident in Massachusetts Bay.

The absence of right whales in the GSC in 1992 can be attributed to a shift in the regional zooplankton community. The dominant taxon was pteropods, distributed vertically throughout the water column, rather than the calanoid copepod *Calanus finmarchicus*, vertically and horizontally aggregated into the dense patches comprising the preferred foraging areas of right whales. Either pteropods are unacceptable right whale prey, or patch densities were below the energetic threshold required for right whale feeding. The shift in zooplankton dominance in 1992 was likely related to significantly reduced water temperatures and a delay in the development of the typical hydrographic structure of the region, possibly caused by: (1) widespread cooling of the Northern Hemisphere caused by atmospheric sulfuric acid haze resulting from the June 1991 eruption of Pinatubo volcano in the Philippines, and/or (2) significant alterations in regional weather patterns in eastern North America during the first half of 1992 resulting from the effects of the 1991/92 El Niño.

NEUROLOGICAL DISEASE AND HUMPHREY THE HUMPBACK WHALE

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Detailed observations of Humphrey, a highly publicized adult humpback whale (*Megaptera novaeangliae*), strongly suggests that he is affected by lesions to the facial nerve and vestibular system. In 1985, 1988, and 1990, he was observed circling repeatedly, wandering, and occasionally beaching himself as he swam in inland waters of California. In these embayments (depth range = 0-5 m), his respiration pattern was atypical, consisting almost entirely of repeated breath intervals of long duration (mean = 3.4 min). He also exhibited this pattern in the relatively deep water of Bodega Bay (depth range = 7-14 m). This pattern differs markedly from that typically observed in other humpback whales occurring along the California coast, which is characterized by 3-6 breaths separated by short intervals (20 sec mean duration) followed by a longer interval (2.4 min mean duration) before repeating.

Analysis of still photos, videos, and recorded observations revealed additional behavioral abnormalities. Photos and video taken in 1985 and 1990 documented that Humphrey's left nare was lame during respiration. In 1985 the aperture of his left nare was only 1/3 the aperture of the right nare, and in 1990 the left nare did not appear to be functioning at all. Also, during his 24-hour stranding in San Francisco Bay, 1990, he exhibited bilateral nystagmus (both eyes moved horizontally in same direction at 2 sec oscillations). Later in the night his left eye stopped moving and was completely insensitive to touch, while the right continued oscillating. When set free the next afternoon he severely listed to the left side, appeared dazed and circled to the left, beaching himself again. Finally, during the second rescue attempt he swam off in deeper water where he was eventually directed back out into the open ocean. Counter-clockwise circling was the predominant movement pattern documented in 1985, 1988, and 1990.

Respiratory dyspnea, facial paralysis, bilateral nystagmus, body tilting, incoordination with consequent drifting, or circling to the affected side may all be caused by lesions to the facial nerve and vestibular system. Similar symptoms have been documented in horses, dogs, and cats, as well as humans. The cause(s) of Humphrey's neurological dysfunction (e.g. parasite, trauma, and/or abscess) is unknown.

MOLECULAR APPROACHES TO MARINE MAMMAL ORGINS.

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Using an extensive library of partial sequence data for the milk protein beta lactoglobulin (BLG) from marine and terrestrial mammals, we have been examining the origin of the pinnipeds, in an attempt to resolve the monophyly/diphyly controversy. The amino-terminal amino acid sequences of BLGs from the cow (Bos taurus) , the goat (Capra hirrus) , the sheep (Ovis aries) , the horse (Equus caballus) , the dog (Canis familiaris) , the bear (Ursus spp.) , the killer whale (Orcinus orca) , the California sea lion (Zalophus californianus) , the dolphin (Tursiops truncatus) , the northern elephant seal (Mirounga angustirostris) , the hooded seal (Crystophora crystata) , the manatee (Trichechus manatus) , and the sea otter (Enhydra lutrus) were aligned and several diffrent algorithms were used to generate phylogenetic trees.

In most cases, the algorithms generated multiple phylogenetic trees, which vary with the order in which sequences are added to the growing tree, as well as with which sequence is used to start the tree. These problems were overcome by conducting multiple runs of each algorithm, varying both the order of sequence addition and the starting sequence. In addition, we attempted to root the tree by including the amino-terminal sequence of BLG from the kangaroo (Macropus giganteus) . Even so, most runs generated multiple trees, reducing the precision of our analysis. However, the trees were sufficiently similar to allow some generalization.

In general, the cetaceans grouped near the ruminants, and the manatee was close to the horse. The pinnipeds grouped together, usually close to the sea otter, and being closer to the dog than the bear. Although these results are not conclusive, due to the rather short amino-terminal sequences studied, they do expand our understanding of the origin of marine mammals in general and the pinnipeds in specific, and support a monophyletic origin of the pinnipedia.

AN ANATOMICAL MODEL OF MANATEE HEARING

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The West Indian manatee, *Trichechus manatus*, is common in the subtropical waters of Florida, and large numbers are injured annually in collisions with boats in shallow coastal waters and canals. Acoustic warning devices may help reduce water craft related injuries, but more information is needed first about manatee hearing. In this study, three-dimensional morphometric models produced from CT scans and light micrographs were used to provide estimates of frequency range and directional sensitivity for *T. manatus* .

The models show that West Indian manatees have superficial auditory specializations similar to cetaceans, but they have inner and middle ears that imply a narrow auditory range and poor directional sensitivity. The middle ear cavity is large, air-filled, and soft-walled with massive, loosely joined ossicles. The inner ear has little base to apex differentiation and low spiral ganglion cell densities. An unexpected finding was that the cochleae are intracranial and separated by less than 100 mm. Possible interaural time distances (IATD) for Florida manatees therefore range from 50 µsec (for soft tissue conduction paths) to 260 µsec (maximal external intermeatal sound paths). This means either manatees have acute hearing above 50 kHz, which is inconsistent with their peripheral auditory system anatomy, or, like some fossorial rodents, they evolved with few selection pressures for acute hearing and have little ability to localize sounds. Our results suggest manatees contradict the convention that hearing is the most significant and developed sense in obligate marine mammals, and, in practical terms, that Florida manatees may be unable to perceive the direction or proximity of approaching boats in time to avoid impact.

MEASUREMENTS OF IMMUNOGLOBULIN CONCENTRATIONS IN EUROPEAN SEAL PLASMA SAMPLES

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To investigate the humoral immune system in seals we have produced monoclonal antibodies (McAb) specific for seal immunoglobulins. Three of these McAbs (H1a specific for an IgM-like macroglobulin, H24b and H49a both specific for IgG-like immunoglobulins) produced against grey seal (*Halichoerus grypus*) immunoglobulin epitopes have been used to measure seal immunoglobulin concentrations. Epitopes recognised appear to be shared across other phocid species.

Immunoglobulin concentrations have been measured in adult plasma samples.

Seal species	Immunoglobulin concentration ± SD (g/L)		
	IgM-like (H1a)	IgG-like (H24b)	IgG-like (H49a)
Grey (n=26)	1.2 ± 0.3	3.5 ± 2.8	25.4 ± 8.3
Harbour (n=25)	1.1 ± 0.2	6.1 ± 3.6	25.3 ± 9.3

Immunoglobulin concentrations measured in neonates were found to be low compared with adults. These values were found to increase during the first 6 weeks post-partum to approximately adult values.

The reagents and methods described here allow the measurement of phocid IgM and IgG-like immunoglobulin concentrations, facilitating study of the immune system in seals.

ESTIMATING TREND OF THE ST LAWRENCE POPULATION OF BELUGAS: EVALUATION OF THE 'GREY INDEX'

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The St Lawrence population of belugas, much reduced by hunting, has been declared endangered. Census surveys indicate that it may be slowly increasing, but they have been too variable to provide statistically significant trend estimates. Grey juveniles are distinguishable in boat surveys, and their proportion in the population has been proposed as an index of population growth. This growth index is more reliable than the gross annual birth-rate if juvenile survival is variable. It has been suggested that this index can be generally applied for monitoring the trend and status of this population.

The validity of this index was tested by modelling the dynamics of the population, using a discrete version of the Lotka equation. The proportion of grey animals -- the 'grey index' -- was a good positive indicator of population growth rate if birth rate or juvenile survival were varied. However, the relationship between the grey index and the growth rate was affected by other parameters of the life history. The grey index was negatively related to population growth rate when age of first reproduction, or adult longevity, were varied. If changes in environmental conditions caused correlated changes in both longevity and juvenile survival, population growth rates could change markedly without greatly altering the grey index.

Interpretation of observed values of the grey index as evidence that the population is increasing or decreasing may be subject to error: values in the observed range could be consistent with an increasing or decreasing population. A continued programme of census surveys is necessary if definitive estimates of trend are to be obtained.

INTRA-SPECIFIC VARIATION IN PIGMENTATION PATTERNS OF THE HARBOUR PORPOISE, *PHOCOENA PHOCOENA* (L.).

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Photographs of 393 harbour porpoises from five subpopulations (Japan, Denmark, and British Columbia, the Bay of Fundy and Gulf of St. Lawrence, Canada) were examined for individual and geographic variation in pigmentation patterns. A classification scheme based on the presence of morphs of 12 pigmentation characters was developed for the analysis. We were able to examine both the left and right sides of 229 animals; all of these showed bilateral asymmetry, establishing a new account of asymmetry in cetaceans. Each of the 393 porpoises examined had unique pigmentation, which may be involved in individual recognition. No morphs of the 12 characters were found to be sexually dimorphic.

Virtually every morph was present in all subpopulations to some degree, making pigmentation patterns an unsuitable tool for absolute discrimination among reproductively isolated groups of porpoises. The frequencies of the morphs of seven characters were significantly different between the five geographical regions, demonstrating that pigmentation patterns are not uniformly distributed throughout the range of the harbour porpoise. This suggests some heterogeneity in the genetic control of pigmentation in these animals.

DIVING ACTIVITY IN NURSING BEARDED SEAL PUPS

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In this study we used time-depth recorders to quantify diving activity of four nursing bearded seal (Erignathus barbatus) pups. The pups were 4-7 days old at the start of the experiments. Their average daily mass gain was 3.3 ± 0.4 kg. A total of 530 h, including 6248 dives, were recorded from the four pups. The pups spent 53 % of the recorded time in the water and 47 % of the time hauled out. When the pups were in the water 42 % of the time was spent submerged, while 58 % of the time was spent at the surface. Most dives were shallow and of short duration. Mean dive depth and duration were 10 ± 10 m and 62 ± 46 s and the maximum recorded values were 84 m and 5.5 min, respectively. The pups spent more time in the water and increased the number of long dives and the mean dive duration with increasing age. The mean duration of haul-out intervals where nursing could take place was 1.9 ± 2.01 h with a maximum recorded value of 8.3 h. The average time between these haul-out intervals was 2.2 ± 2.44 h, with a maximum value of 9.7 h. A diurnal pattern in haul-out activity was documented; pups spent significantly more time hauled out from 7-10 and 21-24 hours than during the rest of the day.

INNER EAR STRUCTURES OF TWO FOSSIL ODONTOCETES, AND THEIR PHYLOGENETIC AND FUNCTIONAL SIGNIFICANCE

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We studied the inner ear structures of two fossil odontocetes: a squalodontoid from the Late Oligocene and a physeteroid from the Miocene. A Croft parallel grinder was used to serially cut their petrosals (periotics) to obtain high-quality sections of the bony labyrinth at precisely controlled increments. Their inner ear structures were then reconstructed by using computer graphics. These techniques resulted in much more accurate measurements of the inner ear structures in fossil whales than previously possible. Based on serial sections and computer-generated endocasts of inner ears, we note that these fossil whales shared several bony features with the extant odontocetes: 1) a very reduced and curved vestibule; 2) very small semicircular canals; 3) a hook in the basal cochlear turn; 4) a very large perilymphatic duct; 5) several bony cochlear structures associated with high-frequency hearing. These features indicate that specializations of the cetacean inner ear occurred no later than the divergence of these two taxa. Several cochlear features are more primitive in the physeteroid than in the squalodontoid. The secondary bony lamina for the basilar membrane in the cochlea is less developed in both fossil taxa than in modern delphinoids. In the squalodontoid, the basilar membrane width increases more rapidly toward the cochlear apex than in delphinoids. These imply that the peak hearing frequencies were lower in these fossil taxa than in extant delphinoids. Our long-term goals are to study the systematic distributions of the inner ear structures in major cetacean clades, and to interpret their phylogenetic and functional transformations.

DIFFERENCES IN RESPIRATORY RATES BETWEN FEEDING AND NONFEEDING FIN WHALES (*BALAENOPTERA PHYSALUS*) IN THE WATERS OFF EASTERN LONG ISLAND, 1981-86.

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Observations of feeding and respiratory behavior of individual fin whales (*Balaenoptera physalus*) were made from various vessels during the months of May - September, 1981-86, in the waters off eastern Long Island. The interval between blows was measured and recorded to the nearest second. Information about the animal's behavior was also recorded, as were the location, depth, and surface temperature at sounding dives. Animals that were observed feeding were noted as such, all others were considered nonfeeding. Data were compiled by individual, month, year, and total and analyzed for mean blow intervals during surfacing sequences; mean dive duration; and overall mean blow interval (from which blows per hour can be calculated).

Overall mean blow intervals (± s.e.) of 49.06 ± 0.96 for feeding (n = 9022), and 57.61 ± 1.01 sec for nonfeeding animals (n = 10115), differed significantly (Mann-Whitney U, $p < .001$). Mean blow intervals for surfacing sequences (± s.e.) of 12.60 ± 0.06 for feeding (n = 6949), and 13.67 ± 0.07 sec, for nonfeeding animals (n = 7654), also differed significantly (Mann-Whitney U, $p < .001$), as did mean dive duration (171.28 ± 2.41, n = 2073, for feeding animals; 194.27 ± 2.70, n = 2461, for nonfeeding animals). Yearly comparisons of surfacing sequence blow intervals between feeding and nonfeeding animals yielded significant differences for each year, while comparisons of dive durations yielded significant differences for all years except 1981 and 1982.

DIVE BEHAVIOR OF BOWHEAD WHALES AS MONITORED BY SATELLITE RADIO-TELEMETRY

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Ten bowhead whales (Balaena mysticetus) were tagged with satellite-monitored radio tags near the Mackenzie River delta in the Canadian Beaufort Sea in late summer 1992. Animals tagged were estimated to be between 8 and 12 meters in length. Tags were applied on the dorsum approximately 2 m behind the blowholes. Tags recorded sensor information on dive durations, dive depths, time spent in specific depth regimes, and time spent at the surface during eight summary periods daily. 2014 transmissions were received. Longest submergence during a summary period ranged from 3 to >61 minutes (n=482). One of the animals moved through areas of heavy ice and may have taken breaths without exposing the tag. Thus our analysis excluded summary periods with submergences longer than 61 minutes. Mean duration of the longest submergence during a period was 19 minutes (n=454, sd=8); mean duration of the deepest submergence during a period was 13 minutes (n=467, sd=7); mean average dive duration during a period was 3 minutes (n=406, sd=2). The deepest dive during a period ranged from <8 to 455 meters (x=91, n=470, sd=2). On average only 4.7 % of each summary period was spent at the surface (n=455, sd=3.1).

SEASONAL PATTERNS IN DENTINAL ZONE FORMATION IN HARBOUR PORPOISES (Phocoena phocoena) FROM THE KATTEGAT AND SKAGERRAK SEAS.

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We analysed decalcified and stained sections of teeth from 65 females and 70 males of harbour porpoises incidentally taken in commercial fisheries or found stranded in the Swedish Kattegat and Skagerrak Seas during 1987-1991. We examined the dentinal zone being deposited, the translucent (light) or the opaque (dark), under transmitted light in relation to the approximate date of death of the animal.

All animals collected during September-February (n=32) were depositing the opaque zone at their time of death. The translucent zone was only forming during March-July in females. Of the 51 females collected during these months 67% were forming the translucent zone. In males, the translucent zone was only being formed in animals collected during March-August. The translucent zone was being deposited in 58% of all the males available (n=50) from these months. The transition period from opaque to translucent zone formation occured in March for females and in March-April for males and the transition period from translucent to opaque zone formation occured in July for females and in July-August for males.

These results show that the translucent zone is formed in the dentine of harbour porpoises during the spring and summer months. However, there are animals forming the opaque zone during this time of the year indicating that the translucent zone is deposited during a relatively short time period.

It is possible that the formation of the translucent zone is linked to the date of birth, seasonal changes in day length and/or hormonal changes in these seasonally reproducing animals.

A COMPARISON OF RECORDED HEAT PRODUCTION AND CALCULATED HEAT LOSS RATES IN HARP SEALS (*Phoca groenlandica*).

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Various heat loss (*HL*) models ('flat plate model', 'cylindrical model', 'modified cylindrical model' and 'equivalent thickness model' (described by Ryg *et al.* 1988, Can. J. Fish. Aquat. Sci., 45:985-992)) have been used to predict metabolic rates (*MR*) and lower critical temperatures of marine mammals and of large whales, in particular. We have investigated which of the four models that is best for use on seals. We recorded *MR* (by indirect calorimetry), deep body and subcutaneous temperatures, and temperature gradients (*TG*) across the blubber layer and into the muscle, in two resting harp seals (*Phoca groenlandica*) when these had reached thermal equilibrium in ice water. The seals were then killed by an injection of pentobarbital/potassium chloride, and core/blubber interface temperatures immediately recorded at 10 different sites, as well as detailed data on blubber thicknesses (*d*) and surface area (*SA*). We subtracted the estimated rate of respiratory heat loss from *MR* and compared the resulting values with the rates of *HL* from their body surface, as calculated based on all four models. Blubber conductivity was assumed to correspond to that of dead blubber, and a value of 0.183 $W \cdot m^{-1} \cdot {}^{\circ}C^{-1}$ (Worthy 1991, Comp. Biochem. Physiol., 100:845-851) was used. *MR* was 3.07 and 6.51 $W \cdot kg^{-0.75}$, weighted mean temperature difference across the blubber layer was 29.17 and 25.15°C, *SA* (excluding front flippers) was 1.75 and 1.18 m^2, and weighted mean *d* was 58.1 and 32.4 mm, in animal # 4 ("fat", 4 yrs, body mass (*BM*)=116 kg) and # 5 ("lean", 5 yrs, *BM*=62.1 kg), respectively. *TG* extended into the muscle layer of both animals. All four models overestimated the rate of *HL* by between 14 and 65%, the 'cylindrical model' yielding the best results (37 and 14% in animal # 4 and # 5, respectively). These results may be modified by upcoming detailed data on harp seal blubber conductivity.

A LARGE AGGREGATION OF BOWHEAD WHALES (*Balaena mysticetus*) FEEDING NEAR PT. BARROW, ALASKA, IN LATE OCTOBER 1992

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On 17 October, during aerial surveys designed to monitor the bowhead whale migration across the Beaufort Sea, we encountered a large aggregation of feeding bowheads about 35 km NE of Barrow, AK. Nineteen sightings for a total of 56 bowhead whales were observed over an area of open water and new ice. The whales apparently were engaged in bottom or near bottom feeding, because we frequently observed muddy water streaming from their mouths when they surfaced. We returned to the area on 19 October and observed 13 groups and 13 singletons, for a total of 104 whales distributed over a 277 km^2 area. The largest single aggregation contained at least 30 whales. Feeding bouts were performed by single whales and subgroups of 2 to 5 whales. We observed both asynchronous and synchronous diving behaviors. One subgroup of 5 whales dove and resurfaced in echelon formation. Most feeding activity occurred in water depths <20 m, although one group was observed feeding in water 126 m deep. Euphausiids were the dominant prey in the stomachs of whales harvested at Barrow during fall 1992, and some of those whales were taken in the described feeding area as early as 27 August. These observations of feeding activity by a large aggregation of bowhead whales were made later in the calendar year than previously reported in the scientific literature, and further demonstrate the periodic importance of Pt. Barrow as a bowhead feeding area in the fall.

CROSS-REACTIVITY OF ANTIBODIES TO HUMAN ANTIGENS WITH TISSUES OF THE BOTTLENOSE DOLPHIN, TURSIOPS TRUNCATUS USING IMMUNOPEROXIDASE TECHNIQUES

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Cross-species reactivity of 53 antibodies used to detect human cellular antigens was evaluated in the bottlenose dolphin Tursiops truncatus,using the three-step labelled avidin biotin technique. Strong cross-reactivity was demonstrated with antibodies against intermediate filaments, most hormones, but few leucocyte antigens. S100, NSE, F8RA, Factor XIIIa, and α-lactalbumin antibodies reacted, while HMB45, EMA, PLAP, PSA did not. Polyclonal antibodies are much more likely to cross-react than are monoclonal antibodies. Some antigens can be demonstrated only after utilizing a special technique to unmask the antigen before staining.

DIET OF NEW ZEALAND FUR SEALS IN TASMANIA, AUSTRALIA, INFERRED FROM SCAT ANALYSIS, AND RESULTS OF FEEDING TRIALS.

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Scats were collected from New Zealand fur seals (*Arctocephalus forsteri*) breeding on Maatsuyker Island in southern Tasmania (43°38'S, 146°16'E). Fish, squid, and salps were detected in the scats. Predominant fish species in the diet were jack mackerel (Carangidae), red bait (Emmelichthyidae), and lanternfish species (Myctophidae). These are all dense-schooling species. Jack mackerel (< 46 cm long) and red bait (< 36 cm long) are quite oily fish, commercially exploited for human consumption, cray bait and fish meal manufacturing. Myctophids are relatively small fish (<10 cm), not caught commercially, but are seasonally very abundant - < 80% total fish biomass in Tasmanian waters. Myctophids are probably important prey of other marine predators. Results of feeding trials with four captive New Zealand fur seals indicate that the majority of squid beaks are vomited, not defecated, and the frequency of vomiting increases when squid are consumed. Few vomits were present at the breeding colonies on Maatsuyker Island so it is inferred that squid are not an important part of the diet.

KINETICS OF ACTIVATION OF IMMUNE CELLS FROM HARBOR SEAL PUPS (*Phoca vitulina richardsi*) DURING THEIR REHABILITATION

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The number of wild Pacific harbor seal pups (*Phoca vitulina richardsi*) in central California requiring rehabilitation has recently increased, yet the underlying causes are not well-understood. Consequently, whether these pups can be classified as a homo- or a heterogenous population in terms of their health profiles remains unknown. If, in fact, an insult to health is responsible for many observed incidents, it is essential to know whether the type of insult is consistent among cases.

The immune system probably represents the most sensitive and accessible indicator of health status. We have optimized two functional assays that measure mitogen-induced (Con A, PHA, PWM) activation of harbor seal peripheral blood mononuclear cells (PBMCs); one measures the proliferative capacity of a population of lymphocytes, while the other examines single cells for expression of the interleukin-2 receptor, a lymphocyte activation marker. Using these parameters as a measure of immunocompetence, we have initiated a long-term study that monitors the immunological profile of pups throughout their rehabilitation. While lymphocyte responses varied among animals, a predominant pattern emerged. In general, PBMC responses decreased significantly after two weeks of rehabilitation. In addition, the differential responses of PBMCs from individuals to the various mitogens indicate a correlation between high response to Con A, moderate response to PWM, and survival. This trend suggests that these measurements of immunocompetence will have diagnostic and prognostic value.

EARLY CALF BEHAVIORAL DEVELOPMENT AND MOTHER-CALF INTERACTIONS IN CAPTIVE KILLER WHALES, *ORCINUS ORCA*

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Killer whale calf behavior and mother-calf interactions from birth through six months of age were recorded as part of a behavioral ontogeny study at Sea World of San Diego. Data were collected on a group of four whales, including a female calf, her mother, an adult female, and a juvenile female. Two sampling procedures were used: (1) 30 min focal animal sampling, and (2) instantaneous scan sampling. For the four whales, 156 hours of focal samples and 7,280 instantaneous scan samples were obtained. Association patterns were determined from the frequency of occurrences of a pair of whales within one body-length of each other. The degree of association for each whale pair was calculated ($a_{ij}=2(N_{ij})/n_{ii}+n_{jj}$). Results indicated the whales were associating 66% of the time. In the first 3 months, mother and calf were nearly in continuous contact (CoA=.98) and less closely associated during the second 3 months (CoA=.83). With her mother present, the calf associated mostly with the juvenile (CoA=.61) and to a lesser degree, the other adult (CoA=.24). Increasingly, the calf associated with the juvenile. The calf did not associate with the other adult without her mother. When associating, the whales were often engaged in social interactions and synchronous behaviors. Changes in mother-calf associations corresponded to the gradual loosening of contact and the formation of association preferences as the calf developed. These preliminary results are consistent with studies of wild killer whales which suggest associations are selective rather than random.

SWIMMING BEHAVIORS AND SPEEDS OF WILD DALL'S PORPOISES (PHOCOENOIDES DALLI)

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Swimming speeds and related surfacing behaviors of wild Dall's porpoises, Phocoenoides dalli were recorded in Blackfish Sound, British Columbia, Canada using a calibrated boat speedometer and high speed cine film. Three surfacing behaviors, slow rolling, fast rolling, and rooster-tailing were recorded at speed ranges of 1.6 - 2.1 m/s, 1.8 - 3.4 m/s, and 3.4 - 6.0 m/s respectively. Above a threshold speed of 3.4 m/s only rooster-tailing was observed, and below only rolling behaviors occurred. Unlike other small cetaceans, P. dalli do not porpoise. Dall's porpoise may have adaptations for reducing drag and maximizing subsurface swimming performance. Predation risk from killer whales (O. orca) is suggested as the principal determinant of the high speed swimming behavior of P. dalli.

DIVING BEHAVIOR OF ELEPHANT SEALS: IMPLICATIONS FOR PREDATOR AVOIDANCE

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We hypothesize that the diving pattern of northern elephant seals, Mirounga angustirostris, is in part an adaptation for avoiding encounters with near-surface predators such as the white shark, Carcharodon carcharias. Predictions from this hypothesis are tested from behavioral observations and from free-ranging dive records obtained from diving instruments attached to 42 seals at Año Nuevo, California, during the period 1989 to 1992. The general diving pattern of elephant seals is consistent with the hypothesis: elephant seals exhibit "yo-yo" diving with no swimming at the surface, brief interdive surface intervals (< 3 min), and long duration diving (mean = 20 min) in the modal depth range of 200 to 600 m. Seals of both sexes and all age categories minimize encounters with white sharks in the danger zone, the routes to and from the rookery over the continental shelf (< 140 m). They swim faster on the shelf than off of it, surface for shorter intervals, and swim to and from the rookery on the shelf bottom. Young seals learn to swim and dive at night, remaining close to shore in shallow water. Breeding-age males, in their effort to mate, spend more time in the high risk zone of attack than females and juveniles and are more frequently injured by sharks. Pups going to sea for the first time suffer the highest annual mortality rate at sea (mean = 46%); the role of white shark predation in causing low survivorship to one year of age is unknown. We conclude that the diving pattern of elephant seals has evolved in part in response to predator pressure.

EFFECT OF FISHERY CHARACTERISTICS ON BY-CATCH OF HARBOUR PORPOISE IN THE GULF OF ST LAWRENCE (CANADA)

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Studies have shown high by-catch of harbour porpoise in groundfish gillnets in the St Lawrence. To find ways of reducing it, it is necessary to relate it to fishery characteristics. From May through August 1992, the practices of 22 Gaspésian fishermen were studied in detail. For 2492 gillnet sets, we collected data on fishing location, target species, water depth, mesh size, net length and height, and length of time fished, as well as catches and by-catches; data were checked by interview.

Three main fishing areas were apparent from the data: the north-eastern Gulf of St Lawrence, the Miscou Banks, and around the end of the Gaspé Peninsula. Of 402 by-caught porpoises, 99.75% were taken in groundfish gillnet fisheries, which accounted for 99.6% of fishing effort (km-hr) and 77.6% of landed tonnage. Within the groundfish fishery, 97.76% of 401 by-caught porpoises were taken in nets set for Atlantic cod, which were 59.5% of effort and 53.2% of landings, and 99.5% were caught in nets set in water shallower than 100 fathoms, although nets set deeper accounted for 40.6% of effort and 41.2% of landings. The highest by-catch rates (≈ 4 porpoises/ton) were on the Miscou Banks and the north-east Gulf.

Fisheries for herring and mackerel are productive (75 kg/km net/hr, compared with 0.5--1.7 kg/km/hr for groundfish), and around the end of the Gaspé Peninsula are simultaneous with groundfish fisheries. But although stomach contents of 72 collected carcasses showed a preponderance of herring and capelin, only one porpoise was caught in a surface-set net.

DIET OF HARP SEALS (*Phoca groenlandica*) IN THE NORTHWEST ATLANTIC DURING 1990-3

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An understanding of geographical and seasonal variations in diet and distribution is necessary before we can estimate the impact of seals on commercial fish species. The diet of harp seals in the northeast Atlantic Ocean around Newfoundland and along the coast of Labrador was determined by reconstructing the contents of 1050 prey-containing stomachs recovered in 1990-3. Considerable seasonal, geographical and interannual variation was observed. Based on wet weight, Arctic cod, followed by Atlantic herring and capelin, were the most important prey of inshore seals along Labrador and the northeast coast of Newfoundland, while capelin and redfish were the major prey along the south and west coasts. Although Arctic cod was the major prey in all seasons, the importance of capelin, herring and squid increased during the summer. Inshore harp seals collected in 1992 contained more capelin and crustacean prey, than in previous years. Atlantic cod accounted for 2..8 to 11% of the diet in any year.

Capelin and sand lance were the most important prey in Newfoundland offshore waters. Atlantic cod was rarely found in the stomachs of offshore seals collected independently of commercial trawlers, although they were the predominant prey of seals caught in the nets of cod-directed trawls. The size classes of cod eaten were similar to, or smaller than, cod discarded by the trawlers.

SOME ASPECTS OF MATERNAL CARE IN THE NEW ZEALAND FUR SEAL, *ARCTOCEPHALUS FORSTERI.*

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The New Zealand fur seal has a limited distribution in Australia, with breeding sites being restricted to only a few islands in southern and western Australia. The southern most colony at Maatsuyker Island is the sole breeding colony in Tasmanian waters. Growth rates, maternal attendance and suckling behaviour of eleven pups at Maatsuyker Island were monitored during the six months following birth in the summer of 1992/1993. Growth rates ranged from 0.05 to 0.08 kg per day. There were however significant inter-annual differences in pup weights over four years. Male pups were also heavier than female pups of the same age in some years. Individual variation in maternal attendance patterns suggest that mothers within a colony can adopt a range of pup rearing strategies.

DISTRIBUTION, ABUNDANCE AND HABITAT ALLOCATION OF DOLPHINS IN THE PACAYA/SAMIRIA RESERVE, PERUVIAN AMAZON

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Vessel surveys were made during high-, mid-, and low-water seasons, 1991-1993, in the Samiria River, Peru, to determine distribution, density and habitat allocation of river dolphins (Inia geoffrensis and Sotalia fluviatilis) within the Pacaya/Samiria Reserve. Data were managed and analyzed using primarily Geographic Information Systems. Throughout Peru, dolphins of both species are found widely in the main rivers, in most free-flowing tributaries wider than 12m and in many larger lakes, at least during high water. Within the Samiria and its tributaries, they were most often at or near (within about 0.32nm of) confluences (63 percent), sandbars or other shoals (16 percent) or particularly sinuous segments of river (11 percent); in all these areas they occurred significantly more than expected in slow counter-current eddies. Within lakes, they were found usually within about 100m of shore (Inia geoffrensis) or equally frequently throughout the lake (Sotalia fluviatilis). Observed group densities were corrected [with data obtained independently (from shore sites, anchored vessels and drifting skiffs) on group size, dive durations, and persistence of water surface disturbances permitting detection] to estimate density and abundance of each species within the river. Densities of dolphins in the study area were higher than densities observed to date for marine dolphins; however, for river dolphins it may be more meaningful to refer to encounter rates and total numbers than to densities.

ANALYSIS OF EVOLUTIONARY RELATIONSHIPS AMONG DELPHININE DOLPHINS USING MITOCHONDRIAL DNA SEQUENCE DATA

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The phylogenetic relationships among dolphins of the subfamily Delphininae (F. Delphinidae) were investigated using genetic data. Species in the genera Stenella (5 species), Delphinus, Tursiops, and Lagenorhynchus were included in the analysis, as well as non-delphinine dolphin species used for outgroups.

Genomic DNA was extracted using phenol-chloroform extraction and the target sequence of mitochondrial DNA was amplified by the polymerase chain reaction using conserved primers. Sequences from the cytochrome-B gene and the control region were obtained by dideoxy sequencing methods.

Phylogenetic inferences were made based on the sequences, primarily using parsimony analysis, and these were compared to relationships implied by accepted dolphin taxonomy. Preliminary analysis of data from the first three species listed indicated that the various species of Stenella have close affinities to the other delphinines and that the monophyly of the genus may be open to question.

GEOGRAPHICAL DISTRIBUTIONS OF NEW ZEALAND FUR SEALS (Arctocephalus forsteri) BASED ON MITOCHONDRIAL DNA HAPLOTYPES

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To detect genetic division among populations of New Zealand (A. forsteri) and among Australian (A. pusillus doriferus) fur seals, nucleotides spanning 361-base pairs of the 5'-portion of the mitochondrial cytochrome b gene were sequenced from 40 individuals. DNA sequence data from the mitochondrial control region and 12S ribosimal RNA genes have also been preliminarily examined.

Five different mitochondrial haplotypes were observed in these novel sequence data for A. forsteri. The geographical distribution of these cytochrome b haplotypes was shown to be heterogeneous by three statistical tests. The major finding of this study is the difference between haplotypes found in forsteri populations from Western Australian rookeries and haplotypes found in New Zealand rookeries. The percent of nucleotide sequence difference found in pairwise comparisons among the surveyed forsteri individuals is in the range 0.28-0.83%. One individual showed an unexpectedly large sequence divergence (range 3.32-4.15%) from all other fur seals in this study. We compare alternative hypotheses that either this individual is a descendant of an ancient maternal lineage which survived a population bottleneck, or that New Zealand fur seals exhibit a rather large amount of genetic variability at this locus, or that this particular individual could be a hybrid.

This study demonstrates that samples taken from routine pup tagging are amenable to the use of molecular tools such as mtDNA sequencing. This tool can be used to (1) define population structure, (2) determine the levels of gene flow, number of migration events, and effective population size of putative breeding groups, (3) determine the range and direction of historical and current population migrations, and (4) assess the impact of human interaction with these natural populations, a subject that is becoming increasingly important to the conservation status of threatened and vulnerable species.

THE EFFECT OF NOISE FROM AN OUTBOARD MOTOR AND A FERRY ON THE VOCAL ACTIVITY OF BELUGA (*DELPHINAPTERUS LEUCAS*) IN THE ST. LAWRENCE ESTUARY, CANADA.

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The St. Lawrence River, a major international waterway, also supports an endangered population of beluga (N=500). During May-June 1990 and 1991, we monitored the vocal behavior of whales before, during and after exposure to noise from a small motor boat and a ferry. Responses showed were similar for both types of vessel. These included a progressive reduction in diversity of call types and in calling rates while vessels were approaching. At distances ≤ 1 km, we observed an increase in the repetition of specific calls and a shift in frequency bands utilized by vocalizing animals. The mean frequency used for communication, normally centered on 3,5 kHz, attained 5,2 to 8,8 kHz when vessels were ≤ 300 m of the whales. These responses appear to be strategies developed to increase the detectability of signals. However, some strategies may also reduce the efficiency of communication which could, in situations where reliable and efficient communication is imperative, limit ways of overcoming stressful or dangerous events.

ORGANOCHLORINE RESIDUES IN PINNIPEDS FROM THE MONTEREY BAY AREA, CALIFORNIA

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This study was conducted to determine the concentrations of organochlorine pollutants in the blubber of three pinniped species which seasonally reside in the Monterey Bay area. Gas chromatography and mass spectrometry were used to identify and quantify the concentrations of DDT compounds, *trans*-nonachlor, hexachlorobenzene, mirex, and polychlorinated biphenyl (PCB) compounds in sample extracts. Blubber from fresh carcasses collected on central California beaches in 1988 and 1989 were analyzed. Collections included samples from *Mirounga angustirostris*, *Zalophus californianus*, and *Eumetopias jubata*. A significant decrease in the levels of *p, p'*-DDE since the United States ban of DDT was expected. The preliminary data show mean *p, p'*-DDE concentrations of 2,240 ppb (wet weight) in *Mirounga* and 17,893 ppb (wet weight) in *Zalophus*, while 2,585 ppb (wet weight) was detected in the single *Eumetopias* sample. The concentrations of *p, p'*-DDE in *Zalophus* described in this study are approximately three orders of magnitude lower than those reported in *Zalophus* blubber in 1971.

EFFECTIVENESS OF ADDING ACOUSTIC CUES TO GROUNDFISH GILLNETS TO MINIMIZE HARBOUR PORPOISE BY-CATCH

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Catches of harbour porpoise in gillnets are common and such mortalities threaten many populations. A test was conducted to evaluate if such catches result from failures to acoustically detect the nets.

Acoustic devices were placed on gillnets to increase the noise they produced and thereby enhance detectability by harbour porpoise. Hauls were monitored by Sea Sampling Program observers who recorded target species catches and by-catch in noise-enhanced and control nets.

Experimental nets caught significantly fewer harbour porpoise; seabird catches were lower but not significantly so; fish catches were not effected. Seals may learn to use enhanced net noise as a guide to steal enmeshed fish.

Further test are presently evaluating a new acoustic device better suited for gillnet fishing.

BODY FAT CONDITION IN HARBOUR PORPOISE FROM BRITISH WATERS

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Specimens of harbour porpoises, *Phocoena phocoena*, from both strandings and by-catch in fisheries around the British Isles since 1985 have been examined. Full autopsies were undertaken on most carcases, and measurements and samples taken. Body fat condition was determined from measurements of body weight, tissue and organ weights, girths relative to body length, blubber thicknesses and blubber lipid content, all collected during this period, along with basic biological data on date of death, sex, age and reproductive status. A total sample of 129 (72 males + 52 females) individuals, with data on most parameters, has been analysed. The results explore firstly, the most reliable indicators of fat condition; and secondly, the variations in body fat condition in relation to age, sex, reproductive status and season, as well as general nutritional and health status. Results showed that mid-girth is a more accurate indicator of body weight than length, and that the small juvenile animals are both relatively and actually fatter than adults. The latter point may reflect the greater surface/volume ratios of young and their need for insulation and thermoregulation. Length, cm (L) and mid-girth, cm (G) together provide the means of most accurate estimation of body weight, kg (W) - important if the carcase is damaged:

$$W = 0.000076.L^{1.2404}.G^{1.5702}.$$

Limited female data indicated that pregnant females were heavier and fatter, and that lactating females were lighter and leaner than anoestrous females. Blubber lipid content averaged 87% wet weight tissue for all classes of animals except neonates which appeared in our samples mainly during June, and had a lower mean of 77% wet weight tissue.

SUMMER AND FALL FORAGING CHARACTERISTICS OF POST-PARTURIENT FEMALE NORTHERN FUR SEALS (CALLORHINUS URSINUS) IN THE BERING SEA

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Little is known about the foraging behavior of individual northern fur seals (Callorhinus ursinus) during the course of the breeding season and their subsequent migration south out of the Bering Sea and into the North Pacific. We used satellite telemetry to investigate the foraging behavior of post-parturient female northern fur seals and analyzed fecal samples from enemas to describe their diet. Five female fur seals were instrumented (4 in July, 1 in October, 1992) with a 1/2 watt satellite-linked time depth recorder (SLTDR) at St. Paul Island. The SLTDRs transmitted data 28 to 144 days after deployment. Foraging locations varied between and within individuals during the breeding season (July-August), ranged from 90-360 km away from the rookery, and occurred primarily over the middle (depth = 50-100 m) and outer (depth = 100-200 m) domains of the continental shelf. As the season progressed females tended to feed farther north (August-October). Most female fur seals dove within 100 m of the surface and dive duration rarely exceeded 5 min. Juvenile gadid fishes, probably walleye pollock (Theragra chalcogramma), were the most commonly identified prey species from one female in July and four females in October. The post-weaning migration of two females indicated that they followed the frontal boundaries of the middle shelf as they migrated south out of the Bering Sea. Both females swam beyond the continental shelf and into the oceanic zone upon entering the North Pacific. This pilot study represents the first continuous, long-term examination of the feeding behavior of individual female fur seals.

HOME RANGE AND GROUP STRUCTURE OF BOTTLENOSE DOLPHINS IN MATAGORDA BAY, TEXAS

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In July, 1992, 35 bottlenose dolphins (*Tursiops truncatus*) were freeze-branded as part of a larger NMFS-sponsored physiology/radio-tracking study throughout western Matagorda Bay, TX. The NMFS study was in response to a major die-off which occurred in the Matagorda Bay to Port Aransas area in March and April, 1992. Photographic surveys in the Matagorda area indicate that at least two thirds of the freeze-branded dolphins were resident in the approximately 90 km^2 study area in the 12 months following the capture effort. Sighting locations support the idea of subpopulations with separate but overlapping ranges. No differences in habitat use or range were apparent by age, sex, pregnancy, or season. In the 12 months following the capture effort, no resightings of freeze-branded dolphins occurred in regular surveys of Galveston and Port Aransas areas, 200 km to the north and south, respectively. These data, taken together with earlier studies, indicate a high degree of site fidelity, well-confined home ranges for inshore "resident" dolphins, and infrequent or no travel of these inshore animals to other major estuary systems. Group sizes ranged from 1 to 18, with a mean of 5.1 ± s.d. 3.66 dolphins (n=143). Though sample sizes were too small to make indices of association very meaningful, some individuals had 2-3 times more freeze-branded affiliates (as measured by dolphins occurring in the same groups during a sighting) than others, indicating wide variation in individual sociability. Affiliations appeared random by sex.

DYNAMICS OF WHITE SHARK (*Carcharodon carcharias*) PREDATION ON STELLER SEA LIONS (*Eumetopias jubatus*) IN CALIFORNIA.

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Little is known about the role of predation in the decline of Steller sea lions (*Eumetopias jubatus*). Off California, white sharks (*Carcharodon carcharias*) are the primary predator on Steller sea lions. We analyzed records of white shark/Steller sea lion predatory interactions for a twenty-three year period (1970-1992) from stranding records along the mainland coast of California, and from pinniped censuses and white shark feeding observations at Southeast Farallon Island, California. White shark attacks on Steller sea lions were recorded year-round, but most shark wounded animals were seen in June, and in fall through early winter. Attacks usually occured at pinniped rookeries and haul outs; white sharks primarily fed on other species of pinnipeds found in greater abundance. Females were attacked more often than males. There was a significant difference in attack records on four age classes; adults were attacked most frequently, followed by juveniles, subadults, and pups, respectively. Bites were usually located on the posterior body regions. The overall impact of white shark predation on the Steller sea lion population is minimal, since white sharks are not usually found in the central and northern parts of the Steller sea lion range. However, there has been a significant increase in white shark predation along the California mainland and at Southeast Farallon Island since the early 1980's. White shark predation may have a potentially important influence on the recovery of Steller sea lions in California if the sea lion population continues to decline and the white shark population increases.

ACTIVITY AND ENERGY CONSUMPTION IN NURSING RINGED SEAL PUPS

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In this study we use time -depth recorders and doubly labelled water to quantify activity and energy consumption of free-living nursing ringed seal pups. The pups (N=3) spent an average of 50 % of the recorded time (1040 h) hauled out on the open ice or in lairs, 40 % of the time in the water at the surface, and 10 % of the time diving. Mean dive duration was 59 ± 64 s. Maximum recorded dive depth and duration were 90 m and 12 min, respectively. Daily mass gain was 0.35 kg of which 76 % was fat, 6 % protein and 18 % water. Average daily CO_2 production was 0.85 ± 0.16 $ml\,g^{-1}h^{-1}$, corresponding to a field metabolic rate of 0.55 ± 0.10 MJ $kg^{-1}d^{-1}$, or 3.8 ± 0.6 times Kleiber's predicted BMR. Average daily milk intake was estimated to be 1379 ± 390 ml. Field metabolic rate for different activies were calulated to be $FMR_{haul\ out}$ = 1.34 BMR, $FMR_{surface}$ = 6.44 BMR and FMR_{diving} = 5.88 BMR.

OCCURRENCE OF THE "BOTO" SOTALIA FLUVIATILIS (CETACEA, DELPHINIDAE) AT PIPA BEAC, TIBAU DO SUL, RN. BRASIL

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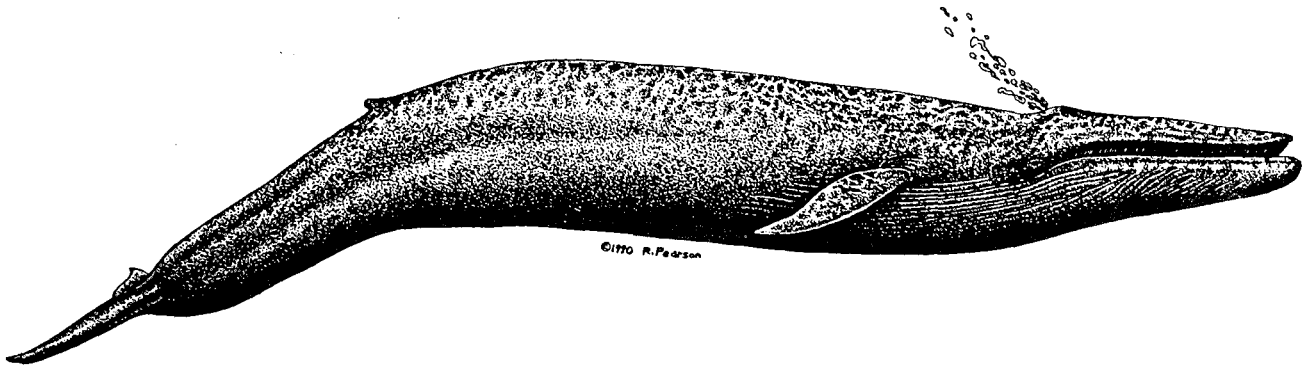
Sotalia fluviatlis (GERVAIS, 1953) commonly known as " boto" has been noticed at Pipa beach, Tibau do Sul (06º 10's; 35º05'w), Rio Grande do Norte State, Brasil. Groups of 4 to 8 animals, even babies, belonging to a fixed population, visit daily a small bay that they use as an alimentation and reproduction area. Among the observed behavion, one an notice "play done mainly by the babies, jumps, fishing, especially "tainha" Mugil curema e "carapeba" Eugerres spp. and mating formation. It is also possible to observe scars in the dorsal fin of the animals, which allows an individual identification. Through the application of questionaires to local fishmen, it is concluded that the presence of "botos" in the region has been verified for many decades, occurring a few cases of death by incidentally catches by nets and later utilization of the specie as a population's alimentation source . Through direct observations, it is verified that this area is also used for babies learning and resting and that with the increase of human's presence, especially by tourism, the frequence of "botos" in the bay, basides behavior's alteration, seems to decrease.



EL NIÑO ISN'T ENTIRELY BAD FOR FUR SEALS

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El Niño events (EN) are widely regarded as a catastrophe in terms of fur seal pup mortality. However, during the 1991/93 EN, an intense and unusually long event covering two consecutive fur seal breeding seasons, pup mortality during both seasons was lower for South American fur seal pups at Punta San Juan, Peru. Normally, in cool non-EN years, pups in this population suffer very high levels of mortality due mainly to high aggression levels at peak female densities during the breeding season. Between 1984 and 1990 (cool to mildly warm), pup mortality during the breeding season ranged between 30% and 49%. In contrast, during the 1991 and 1992 EN seasons, mortality was significantly lower: 20% and 15% respectively ($F_{1,5}$=8.45, $p < 0.05$). This lower mortality was related to significantly lower numbers of females ashore ($F_{1,5}$= 15.54, $p<0.05$) around the peak of births in November. At these lower densities pups were exposed to reduced aggression levels and, thus, the reduction in mortality.
Lower female densities ashore resulted from a lower proportion of animals returning to the breeding beach in 1991 and 1992 (47.5% and 38% of all known females respectively). In previous, non-EN, years at least 90% of all known, tagged females returned to breed each year (range 88-99% for 1985-1990). Pregnancy rates in 1991 and 1992 (78% and 71% respectively) did not differ significantly from those recorded in non-EN years (range for 1985-1990: 72-84%).

BOTTLENOSE DOLPHINS (TURSIOPS TRUNCATUS) OFF OF CAPE MAY COUNTY, NEW JERSEY

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As part of a long-term study of coastal bottlenose dolphins off Cape May, photo-identification work was begun in 1990. The dolphins being studied belong to a seasonal population which occurs off the coast of New Jersey from April to October. In the period of 1990, 1991 and 1992 photographs were obtained during 85 encounters. Resights from year to year of individually distinctive animals indicates that the same groups return to the study area each year. Resights within a season show residency from at least mid-June to mid-September.

THE BEHAVIORAL ECOLOGY OF WILD BOTTLENOSE DOLPHIN MOTHER AND INFANTS FROM BIRTH TO WEANING

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Several developmental patterns are examined among 26 wild bottlenose dolphin mother-infant dyads: 1) Changes in mother-infant proximity from birth to weaning (~4 yrs); 2) Behavioral development; 3) Individual infant characteristics; and 4) Sex differences in play. Longitudinal analyses of ~800 focal hrs. suggests that mother-infant proximity declines with age, but the variation in proximity and behavior patterns between infants is more striking than age effects. Infant activity differs markedly when with (<10m) and when away (>20m) from the mother. For example, when yearlings are away from their mothers they are alone ~60% of the time, mostly hunting. Infants rarely hunt when with their mothers. When they join another animal, it is usually another infant, (~24% of the time away from the mother). In other words, ~84% of the time that yearlings are away from their mothers, no adults are present. Although, nulliparous females associate with very young infants (0-3 months) away from the mother (possibly indicative of allomothering), future infant associations when separated from the mother almost exclusively involve other infants. Male and female play patterns differ markedly, with males spending more time playing with same-sex partners than with opposite-sex partners, and females spending more time playing with opposite-sex partners than with same-sex partners. The significance of these patterns in terms of their potential costs and benefits and in the context of the larger fission-fusion social system are discussed.

PARASITISM, METABOLIC REQUIREMENTS, AND AFFECTS ON THE LIFE SPAN OF *Phocoena phocoena;* POSSIBLE CAUSAL MECHANISMS FOR PAEDOMORPHISM IN PHOCOENIDAE (CETACEA: ODONTOCETI)

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The metabolic implications of a multiple helminthiasis as a possible influencing factor on the reduction of the maximum life span estimated for the harbor porpoise, *Phocoena phocoena*, was examined in the light of the theoretical metabolic requirements of the species. Based on the prevalence and intensities of parasitism documented on stranded as well as free living adult porpoises, the species is considered to have a high tolerance level to increased infestations of helminth parasites. Such tolerance is often attributed to a highly co-evolved, host-parasite relationship from which no lethal effects should be expected. Under this assumption, the occurrences of pathologies associated with the presence of parasites were examined in three metabolically important target organs: lungs, liver, and pancreas. All these organs are commonly severely impacted.

The second assumption is that compared to other cetaceans of similar body size, *P. phocoena* has a high resting metabolic rate. Under this second assumption and considering a theoretical, restrained energy budget predicted for this species, it is interesting to speculate about how an adult host is energetically able to allocate enough energy to counteract the effects of parasitism and still maintain its homeostasis to reproduce successfully without any long term compensatory trade-off.

However, the trade-off appears to be in the comparatively short average life span of *P. phocoena*. These factors might also explain the evolution of paedomorphism in phocoenids, a phenomenon that is prevalent in all living members of the family and which appears to have become progressively more extreme through the course of evolution of the family over the past 8 to 10 million years. If this is true, then accelerated maturation, under pressure to reproduce successfully before life is prematurely terminated by severe parasitism, might have been the causal factor for the evolution of paedomorphism in the family Phocoenidae.

AERIAL BEHAVIOUR IN FIN WHALES (Balaenoptera physalus) IN THE MEDITERRANEAN SEA

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Different kinds of aerial behaviour are well-known in many large whale species, but in Balaenoptera physalus (fin whale) have been rarely reported and are considered very rare.
In the Mediterranean Sea, Balaenoptera physalus is the most common species among the large whales.
In the course of the cetacean survey that our group has carried out in the Tyrrhenian Sea from 1989 to 1992, aerial displays of Balaenoptera physalus have been directly recorded in five occasions (4% out of a total of 124 sightings of this species).
All the recording of aerial behaviour were made during periods in which the density in this area seems to be medium: the maximum of the presence in the area were recorded in April-May and in October (respectively for the migrations northward and southward) and the minimum in November-December.
When the schools were composed by two animals, the breachings were performed by both of them. Generally, the breachings were performed in different ways: in some cases the whales came up vertically with half of the body, splashing on the back or on the right flank, while in other occasions they breached out almost completely splashing on the right flank or on the belly. In one occasion two whales breached and splashed with their belly up. These patterns seems to be quite different from the breachings described by for the humpback whale (Megaptera noveangliae), which come out on a flank and splash on the back after having rotated in the air.

OCEANOGRAPHIC AND BIOLOGICAL CHARACTERISTICS OF SIGHTING LOCATIONS FOR CETACEANS IN WATERS OFF NEWFOUNDLAND AND LABRADOR

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Cruises were conducted throughout waters off Newfoundland and Labrador during the summer of 1993 as part of the YoNAH program. Humpbacks were photo-identified and biopsied according to YoNAH protocol. When any cetacean was sighted Conductivity/Temperature/Depth (CTD) profiles were obtained, water visibility and productivity were assessed, and associated seabirds censused. These data were compared to transect locations where no cetacea were present.

Waters around Nfld./Lab. have been exceptional for the third year in succession, generally the coldest ever recorded. This has altered the distribution of many species, including cetaceans who exhibit restricted ranges which correlate with water conditions.

DIGESTIBILITY OF KRILL IN CRABEATER SEALS AND MINKE WHALES.

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Both the minke whale (*Balaenoptera acutorostrata*) and the crabeater seal (*Lobodon carcinophagus*) prey on krill. The minke whale have a multi-stomach system with a large fore stomach containing both chitinase-producing and other bacteria for microbial fermentation of the prey. The crabeater seal, on the other hand, rely on the single-stomach system which is typical for carnivores. We have used the Mn-marker method of Fadely *et al.* (J.Wildl.Manage., 1990, 54: 246) to test to what extent this basic difference is reflected in their ability to digest krill. Energy content of fresh faecal samples obtained from recently killed animals and from fresh krill was measured by use of bomb calorimetry. The digestible energy (DE) of krill (*Thysanoessa* sp.) in minke whales was 92.2 ± 2.8 (SD) % (n=6), while DE of krill (*Euphausia superba*) in crabeater seals was 83.8± 2.2 (SD) % (n=7). These values are significantly different ($P<0.05$). This result indicates that the more complex multi-stomach system of minke whales improves the ability to digest prey items such as krill, but it is well worth noticing that the digestibility of krill in crabeater seals is still rather high.

SOME ECOPHYSIOLOGICAL ASPECTS OF ENERGETICS IN SEALS.

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For several years the interaction between seals and fisheries has been the subject of debate. In light of this discussion the energy requirements and the food consumption in seals, as individuals and at the population level, are estimated. The results are derived from a combination of laboratory experiments and the development of a physiologically based simulation model. Two physiological principles in particular affect estimates of energy requirements. The metabolic depression during starvation will act to reduce the metabolic rate and thus lengthen the survival time during a period without food. The metabolic depression in seals differs from the metabolic depression observed in terrestrial mammals as the metabolic rate is reduced early in the starvation period and remains at a stable level 20% below the postabsorptive level for at least two weeks of starvation.

On the other hand, consuming food increases the metabolic rate. The heat increment of feeding results in an increase in energy requirement of 5-10% of gross energy intake depending on the energy content of the food consumed. The heat increment of feeding is beneficial to animals in cold environments since it helps to keep the body temperature at a constant level.

PERIORAL BRISTLES: A CLOSER LOOK AT MANATEE FEEDING BEHAVIOR

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We wished to carry out a systematic quantitative study to determine which bristles are used during feeding and under what conditions the pattern of their use varies. Captive manatees were videotaped feeding on four types of vegetation: Hydrilla, Tape-grass, Water Milfoil, and Water Hyacinth. Vegetation was selected to represent a range of morphology and texture. When investigating vegetation, manatees pulled the fleshy portion of the rostrum dorsally and caudally. This behavior flattened the perioral region and increased its surface area. The fleshy rostrum and the lower jaw, in conjunction with the bristles, undergoes repetitive cyclic movements used to gather and ingest vegetation. Each cycle lasts 0.5 seconds and consists of protrusion and extension of upper bristle fields in a sweeping motion toward and into the mouth as the jaw opens. As the upper lips and bristles retract to their original position, the bristles of the lower lip pad extend and the jaw begins to close. At its most dorsal position, the lower bristles sweep vegetation caudally into the mouth. The cycle is then repeated. The frequency and pattern of manipulation change depending upon the type of vegetation presented.

REPRODUCTIVE PARAMETERS OF FEMALE LONG-FINNED PILOT WHALES (*GLOBICEPHALA MELAS*) AROUND THE FAROE ISLANDS

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Between July 1986 and June 1988, 3250 long-finned pilot whales taken in the long-established Faroese drive fishery were carefully examined, measured and sampled as part of a multi-disciplinary research project. Using data from 1680 females, estimates were derived for all the major reproductive parameters.

Females of this species ovulate for the first time at an average age of just over 8 years and continue throughout life, though few conceive at ages above 40 years. Conceptions are spread throughout the year, but peak in summer. Using novel analytical techniques, we estimate the gestation period in long-finned pilot whales to be around 12 months, some 3-4 months less than had been generally accepted. We will explain why most studies have over-estimated the length of pregnancy in cetaceans with a protracted breeding season, and the impact this has on estimates of other measures such as the duration of lactation and the rate of reproduction. Pilot whales in this population have an average inter-birth interval of a little more than 5 years, similar to that of the killer whale (*Orcinus orca*) and one of the slowest rates of reproduction known in cetaceans.

THE ACOUSTIC BEHAVIOR OF HUMPBACK WHALES, MEGAPTERA NOVAEANGLIAE, IN A HIGH LATITUDE FEEDING GROUND.

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Humpback whales (Megaptera novaeangliae) are perhaps the most vocal mysticetes. Their vocalizations on the breeding grounds have been the focus of intense study over the past two decades, but vocal activity in high latitude feeding grounds has received only rudimentary study. We recorded humpback whales on 14 days for a total of 567 minutes in 1990-91 on Stellwagen Bank, a feeding ground in the southern Gulf of Maine. Recordings emphasized those behavioral states when previous casual effort had revealed the whales likely to be vocally active (i.e. social or feeding aggregations). From these recordings we a) describe a repetoire of 17 discrete call types; b) examine the frequency and ordinal pattern with which these calls were made; and c) document sounds produced by two humpback whales entangled in gill nets. Sounds were analyzed using Canary software on an Apple Macintosh computer. A total of 4,540 discrete sound events were recorded. These were most often barks (n=1,830 - a short, abrupt sound with peak frequencies at approximately 800 Hz) or chirps (n=783 - a rapid frequency downsweep starting at 2-3 kHz and descending to 500 Hz). Mean call rates ranged within each recording from 0.5 - 36.2 calls/minute, with an overall mean call rate of 7.34 vocalizations/minute. The highest call rate came from a recently entangled female humpback. To determine whether there was any structure to the order of recorded calls, a first-order Markov matrix of 890 transitions was conducted using a condensed repetoire of 11 call types. While the sample size is small, in at least some cases transitions were not occurring in random sequence. These data indicate that both sexes vocalize on the feeding grounds, and that ordered vocal activity may play an important role in maintaining the social structure of these animals.

SIGHTING DISTRIBUTION OF HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) OFF THE NORTHWESTERN COAST OF PUERTO RICO

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The waters between Puerto Rico and the Dominican Republic constitute transit areas for the winter migration of the humpback whale (*Megaptera novaeangliae*). As a parallel study of the YoNAH (Year of the North Atlantic humpback whale) project, a sighting distribution study was carried out between January and March of both 1992 and 1993 off the northwestern coast of Puerto Rico. During 1992, 57 humpback whales were sighted in 23 cruises while in 1993, 87 humpback whales were sighted in 44 cruises. Two distribution clusters were apparent, one off Punta Higuero in Rincón and another off Punta Borinquen in Aguadilla. Preliminary analysis of the sighting distribution of the whales, indicated that there were no differences between the distribution and group composition (singles, pairs, trios and mother/calf pair) when the results were compared with results obtained between 1979 and 1983 in the same area by one of the authors. From this, it seems that humpback whale distribution and group composition in Puerto Rico do not show any significant variations in the past 14 years.

CHANGES IN PRINCE WILLIAM SOUND KILLER WHALE PODS FROM 1984 TO 1992.

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Major resident killer whale pods have been monitored photographically since 1984 and vital rates developed. Mortality rates of nearly 10% for one pod (AB pod) were first observed in 1985 and 1986 and apparent bullet wounds were observed on some members of the pod. AB pod mortality rates declined until 1989 and 1990 when they increased to 19.4% and 20.7%. Mortality rates averaged 1.4% for all other pods for all years. Mortalities were primarily among juveniles and reproductive females which are groups that generally exhibit very low mortality rates. Mortalities were from within maternal groups.

AB pod numbered 35 whales in 1984 and 25 whales in 1992. All pods other than AB pod have increased in number since 1984. AB pod has shown some recovery with three new calves born since 1990. Possible causes of the extreme mortality rates include interactions with the blackcod longline fishery and the Exxon Valdez oil spill.

DISTRIBUTION OF CETACEANS IN CENTRAL CANARY ISLANDS

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The ocurrence of twenty one cetacean species have been recorded around the waters of the Canary Archipelago, mainly from stranded animals.

From November to February of 1993 low altitude aerial surveys were flown along ramdomly selected transects in six blocks between central Canary Islands of Tenèrife, Gran Canaria and Fuerteventura. The ocurrence of twenty one cetacean species have been recorded around the waters of the Canary Archipelago, mainly from stranded animals.

Sixty three sightings belonging to the follows species were recorded: ***Balaenoptera physalus, Physeter macrocephalus, Kogia breviceps, Ziphius cavirostris, Mesoplodon sp, Delphinus delphis, S. coeruleoalba, S. frontalis, Tursiops truncatus, Grampus griseus, Globicephala macrorhynchus*** and ***Pseudorca crassidens.***

Most frequent species sighted were Striped dolphin ***S. coeruleoalba.***

SATELLITE-MONITORED MOVEMENTS OF BOWHEAD WHALES

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Twelve bowhead whales, (*Balaena mysticetus*) were radio tagged in late summer 1992 in the Canadian Beaufort Sea near the Mackenzie River delta. The tags were located and monitored by satellite. Despite being tagged within one week in the same area, whales did not move "en masse." Variations in direction and water depth were observed for different individuals.

Tags were heard up to 50 days after tagging. Tagged whales were tracked over 12,000 km. At least six of the tags likely stopped transmitting because of low battery voltage. One whale was located 278 times during 34 days as it moved from Canada to Siberia. Satellite images showed a close association with the pack ice edge during migration through the Chukchi Sea. Temperature data also reinforce the bowhead's image as a pagophilic (ice-loving) species. This study is the first documentation of bowhead whale migration across the Chukchi Sea.

SEASONAL DIVING BEHAVIOUR OF THE NEW ZEALAND FUR SEAL, *ARCTOCEPHALUS FORSTERI*

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As part of a feasibility study on New Zealand fur seal foraging behaviour and energetics, variation in diving pattern was examined in late summer and mid-winter using microprocessor Time Depth Recorders. Of 13 deployments on females at the Open Bay Islands, New Zealand, 7 dive records were successfully retrieved.

Most dives were less than 100 m in depth, though instrumented seals tended to dive deeper more often during winter than in late summer. Of 687 dives recorded for female OBI2 in late July (Austral winter), 424 (about 62%) were shallower than 100 m, while 123 (about 18%) were between 220 and the maximum depth recorded of 238 m. The average time submerged during these deep dives was 8.7 min (s.d. ± 1.2 min, range: 4.8–11.2 min). Trip duration ranged from 2–7 days in late summer and 4–12 days in winter. The flat nature of many dive profiles and the surrounding bathymetry suggests that some dives were to the sea floor, possibly near the edge of the continental shelf.

Fur seals prey upon arrow squid (*Nototodarus sloanii*) during summer, but may have to range further and prey upon less accessible species during winter. The success of this initial study has lead to a major research programme on seasonal foraging biology and energetics of NZ fur seals.

FORAGING STRATEGY OF SOUTHERN ELEPHANT SEALS

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The South Atlantic is a vast, patchy and shifting environment. Which of its environmental features are important to southern elephant seals and what strategy do the seals use to find prey?

Three post-breeding and ten post-moult elephant seals were fitted with SMRU ARGOS satellite-link data loggers in 1990 and 1992 at South Georgia, resulting in over 1900 seal days of data. Four seals were tracked over the whole period from moult to breeding. Seal movements were grouped into easterly open-ocean tracks, which showed little correlation to topography, and tracks which were associated with the continental shelf, either at South Georgia or the Antarctic Peninsula, where diving was mainly benthic. Some seals spent periods of a month or more in specific locations, while others spent most of their time on the move. Areas of little movement may be related to the patchy distribution and mobility of prey items in the open sea. Two seals which were tracked over two seasons closely followed their first routes. Dive behaviour (which included dives lasting over 1.5 hours and greater than 1600 m) varied both between seals and as a function of distance travelled each day, time at sea and local topography.

BEHAVIORAL DEVELOPMENT OF CAPTIVE BORN KILLER WHALE (ORCINUS ORCA) CALVES; DAY #1 THROUGH DAY #365

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Records from seven separate marine zoological facilities provided developmental information on fifteen (7 males and 8 females) killer whale calves (Orcinus orca). In some categories, however, a sample size of fifteen is not available due to calf mortality, non-occurrence of certain behaviors, non-availability of certain records, or incomplete record keeping. The occurrence of first spontaneous vocalizations ranged from 1 to 11 days with a mean of 6.4 days (n = 7). First attempts at behavioral mimicry ranged from 12 to 69 days with a mean of 37.9 days (n = 7). The initial occurrence of swimming with whales other than the mother ranged from 11 to 52 days with a mean of 20.5 days (n = 8). As indices of biological developmental markers, data on tooth eruption, growth rates, and nursing are used as comparisons with behavioral developmental patterns. Many of these data do not have the benefit of large sample sizes, making conclusions difficult. The information provided by even small samples, however, illuminates aspects of development that have not been previously observed.

TEMPERATURE REGULATION OF THE DOLPHIN TESTIS

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Dolphins possess a counter-current heat exchanger (CCHE) that functions to cool their intra-abdominal testes. Spermatic arteries in the posterior abdomen are juxtaposed to veins returning cooled blood from the surfaces of the dorsal fin and flukes. We designed a rectal probe housing a linear array of copper-constantan thermocouples to measure colonic temperatures simultaneously at positions anterior to, within, and posterior to the region of the colon flanked by the CCHE. Temperatures of males were taken under a variety of resting conditions, and before and after open water swimming. Under resting conditions, temperatures at the CCHE were 0.9-1.3° C cooler than temperatures recorded posterior to this region in a sexually mature male, and 0.2-0.7° C cooler in peripubescent males. After an extended swim, temperatures in the region of the CCHE were 0.2-0.3° C cooler than they were before swimming. These results support the hypothesis that cooled blood returning from the periphery is introduced into the deep abdominal cavity and actively functions to regulate the temperature of arterial blood flow to the dolphin testis.

ANALYSIS OF WHISTLE STRUCTURAL DEVELOPMENT IN CAPTIVE INFANT BOTTLENOSE DOLPHINS USING A NEW QUANTITATIVE TECHNIQUE

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Vocal learning is thought to play a role in the ontogeny of dolphin communication but little is known about its role in shaping infant repertoires during the first year of development. This study reports on the first six months of vocal development in nine infants from differing social and acoustic environments. Methods included a focal animal sampling technique using 2.5-minute interval and event/continuous sampling recorded on audio or video. A new quantitative was developed to classify whistles based upon whistle contour. Vocal analysis focused upon the structural and behavioral changes during infant whistle development. Approximately 700 whistles were analyzed from individually identified infants. The results suggest that infants produce up to 14 whistle contours and share as many as 3 whistle contours during the first six months. Whistles were produced primarily in contexts of mother-infant separations. In addition, the number of whistle types for each infant decreased over the first three months and then increased from three to six months. Further analyses will determine the acoustic parameters which infants imitate initially and over development and the social and environmental influences on infant whistle development during the first year.

MORPHOLOGICAL DISCRIMINATION OF RINGED SEAL *POPULATIONS*

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Of some nine described subspecies (excluding obvious synonyms) of the circumpolar ringed seal, Scheffer (1958) retained six. Because size in ringed seals is ecophenotypically influenced, size should be removed in morphometric analyses. Although others have recognized this and have even sought allometric differences among populations, no study has been formally adequate. A data set of 18 measurements from 1023 ringed seal skulls, predominately from Alaska, the Canadian Arctic, Greenland, Lake Ladoga and the Baltic, has been analyzed using suggested methods for removing size prior to principal components analysis and subsequent discriminations. This still results in good discrimination among and high assignment fidelity to geographically disjunct populations. However, size is not totally removed, and ecophenotypic distortion of allometry by the interaction of growth and maturation cannot be discounted. Discrimination among ringed seal populations will probably have to rely on molecular techniques.

MITOCHONDRIAL GENETIC VARIABILITY OF HUMPBACK WHALES, *MEGAPTERA NOVAEANGLIAE*, AT MEXICAN PACIFIC.

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Humpback whales, *Megaptera novaeangliae*, represent a large fraction of the North Pacific population. Photoidentification studies show that whales are separated in the Revillagigedo Archipelago and the mexican coast subpopulations. In order to better determine the relationship of humpback whales at North Pacific, skin samples at Bahía Banderas and around Isla Socorro were obtained. A 320 bp fragment of the mitochondrial D-loop was sequenced and compared to sequences from other North Pacific aggregations. Six haplotypes were found being two of them related to types from Southern hemisphere. Data confirm the distinction of the Alaska/Hawaii and California/México subpopulations. A clinal distribution of haplotypes at mexican coast and a related time genetic structure were also observed. Humpback whales from Revillagigedo are genetically similar to the mexican coast and California aggregations with differences at thereshold of statistical significance. This fact is interpreted as a recent divergence which has been estimated to occur around 12 000 years ago. Current distribution and genetic variability of humpback whales at american breeding grounds are thus explained based on the climatic changes ocurred during this time.

FORAGING BEHAVIOR OF FEMALE CALIFORNIA SEA LIONS AT SAN MIGUEL ISLAND, CALIFORNIA: WINTER 1992 AND 1993

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Satellite-linked time-depth recorders were deployed on 10 lactating female California sea lions from November through June to determine winter/spring foraging locations and behavior. Based upon 1,523 at-sea locations recorded by Argos satellites, females foraged northwest of San Miguel Island, as far as 460 km north along the mainland coast and up to 230 km offshore. Mean dive depths ranged from 88 to 203 m. The deepest recorded dive was 482 m. Diving behavior changed with foraging location for some females. Females spent at least 70 percent of their time at sea; attendance patterns became more variable from March through May coinciding in time with weaning of pups. The most frequently occurring prey based upon scat collections during 1992 were Market squid (53.9%), Pacific Hake (38.0%) and rockfish (31.4%). Frequency of occurrence of Market squid increased in the diet from November through February and fish increased in February through June.

These sea lion females dove deeper and were distributed farther north and offshore than has been reported for lactating females during the summer months. However, the El Niño that extended from winter 1992 through 1993 may have contributed to the increased foraging ranges of the females in this study. The results of this study demonstrate the flexibility in foraging behavior of sea lion females.

METHODS FOR THE AUTOMATIC DETECTION OF MYSTICETE CALLS

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The detection of animal calls has several important biological applications. A given species can be detected over a wide area, allowing censuses of populations or species and measurement of ranges. Individual animals may be detected and acoustically tracked for studies of call timing, frequency, and other characteristics; and for behavioral investigations, both on a small scale with individual animals, and on larger scales up to worldwide migration studies. Automated call detection is also useful in the screening of recordings, where typically thousands of hours of tape must be analyzed to find sections where the species of interest occurs.

Methods for automatic acoustic detection are described. The methods take as input a live or recorded sound signal from a hydrophone, digitize it for computer use, compute a spectrogram (time x frequency image), process it as described below, and produce as output a set of times at which the calls of interest occur. Three processing methods are discussed. The simplest is an energy detector, which measures the energy of the frequency band in which the call occurs. The times at which this measure is above a set threshold are marked as calls. A second method uses cross-correlation of a spectrogram with a kernel; the kernel is designed for the given call, and produces a strong correlation value when the call happens. The value is then thresholded for detection. A final method uses a neural network applied to a spectrogram to recognize the call of interest; this network has an output unit that responds when the call occurs.

These methods have been tested on a variety of mysticete calls in a variety of noise environments. The energy detector works well with simple calls such as finback (*Balaenoptera physalus*) pulses in relatively constant-noise environments, such as some hydrophone-array recordings made in the North Atlantic in winter. The correlation method works well on these sounds too — with an error rate, by one measure, about 37% less than the energy detector — and has functioned effectively at recognizing bowhead whale (*Balaena mysticetus*) calls recorded in a noisy arctic environment. It has also performed effectively at detecting blue whale (*Balaenoptera musculus*) calls in the North Atlantic and somewhat less well at detecting minke whale (*B. acutorostrata*) calls from the same place. The neural net was tested on the same set of bowhead whale calls as the correlation method, and performed with a very low error rate.

Phylogenetic Implications of the Facial Morphology of the Sperm Whales (Odontoceti: Physeteridae).

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The sperm whales are the oldest family of Odontoceti with extant representatives. Numerous taxa have been described but little has been done in resolving the relationships between them. All sperm whales (fossil and Recent) have the basining of the skull associated with the spermaceti organ. Considerable variation occurs within the facial basin and adjacent areas. Two subfamilies are recognized: the Physeterinae (true sperm whales) and the Kogiinae (pigmy sperm whales). The Kogiinae are highly derived and diverged from the Physeterine line in the mid-Miocene. The lineage giving rise to the Recent *Physeter* includes *Aulophyseter*. The widening of the facial basin, small temporal fossae, and marked reduction of maxillary dentition characterize this lineage. On the basis of facial characters, a phylogeny of the physeterids will be proposed.

SIGNAL OR NOISE: AN EVALUATION OF CETACEAN SYSTEMATIC STUDIES

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Taxonomic affinities of whales and their relatives are poorly known, and increasing attention to this subject in recent years has generated controversy rather than resolution. Phylogeny estimates from molecular data differ from those based on morphological data both for living and for extinct taxa. Additionally, phylogenetic estimates from different molecular data sets exhibit incongruence. Despite the appearance of conflict in the data, however, the question remains as to whether molecular and morphological data are just noisy, merely represent sampling error, or are giving truly different phylogenetic signal (e.g., organismal versus gene phylogenies). Statistical methods are being developed that will enable us to evaluate this question, and an application of them to my own morphological data and molecular data sets from the literature, will be presented. If the tests indicate that the morphological and molecular data are yielding significantly different signals, identification of the underlying causes of these differences may provide resolution.

PCBs AND ORGANOCHLORINE CONTAMINANTS IN RORQUAL WHALES FROM THE GULF OF ST. LAWRENCE, CANADA.

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In order to assess the levels of contamination of rorqual whales that feed during the summer months in the outer Gulf of St. Lawrence, biopsy samples were removed from the blubber of live specimens of 4 species of whale (Megaptera novaeangliae, Balaenoptera acutorostrata, B. musculus, B. physalus) and analyzed for levels of PCBs and organochlorine pesticides. Although concentrations of these compounds varied considerably between individuals, levels of PCBs, and ΣDDT were generally in the 1-5 µg/g (wet wt.) range, and cyclodiene insecticides and HCH compounds were generally in the 0.1-0.5 µg/g range; 1-2 orders of magnitude below average concentrations of these compounds in the blubber of beluga whales from the inner Gulf of St. Lawrence. Toxaphene concentrations varied between 0.1 and 2.8 µg/g. Samples of 3 blubber strata were also removed from dead whales in the Gulf (3 minke, 1 blue) to determine whether the outer layer of blubber, which is sampled by the biopsy technique, provides a sample that is representative of contaminant concentrations throughout the entire blubber mantle. Contaminant concentrations in the outer layer are representative of all blubber strata when the concentrations are expressed on a lipid weight basis (i.e. ng per g of lipid). These data indicate that biopsy sampling is a valid method for monitoring concentrations of lipophilic contaminants in balaenopterid whales.

CONSERVATION AND MANAGEMENT OF AUSTRALIAN MARINE MAMMALS

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The conservation of Australian marine mammals is considered both from a species and habitat approach. There are a number of species whose conservation status in Australia needs to be reassessed in light of recent population estimates such as the Australian sea-lion, fin and sei whales and dugong. Most of the Australian cetacean species are placed in the Insufficiently Known category by IUCN; one task is to prioritise for assessment the 35 dolphin candidate species.

Recent Federal Government legislation, initiatives and projects include the *Endangered Species Protection Act 1992*, development of a National System of Marine Protected Areas under the Ocean Rescue 2000 Program and the National Database on Endangered Species.

Three regional management issues are discussed: offshore petroleum exploration and southern right whales; traditional harvest of dugong in Torres Strait and the Conservation Strategy for the Australian Antarctic Territory.

SUMMER DISTRIBUTION AND GROUPING PATTERN OF BELUGAS IN ST.LAWRENCE ESTUARY: AN INSIGHT INTO THEIR SOCIAL STRUCTURE

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The St.Lawerence beluga population ranges during summer within a small section (200 km) of the estuary. Systematic aerial (N=20) and boat surveys (249 transects covering 4996 km) between 1986 and 1992 were used to describe its summer distribution and grouping pattern. Aerial surveys using two aircrafts allowed completed coverage of the summer range within less than 4 hours and yielded almost instantaneous images of the distribution and grouping pattern of the entire population. Total visual counts averaged 449,9 whales (coeff. of variation = 9,2 %) distributed in 19 to 35 aggregations refered to as herds. Herd composition was described from the boat transect observations (325 herds; 6280 individuals) using the proportions of calves, juveniles and adults estimated from relative size and coloration. A clear and persistent spatial segregation between adult and adult and juvenile herds roughly coincided with the boundary between the middle and lower estuary. Herd size (2 to 209) and group size (1 to 16) varied considerably suggesting an ever-changing dynamic. Jarman's typical group (herd) size and frequency distribution of animals in arbitrarily defined size-classes were used to compare grouping pattern. More than 80 % of the whales observed in the lower estuary were found in herds of over 30 individuals, whereas such large herds accounted for less than 40 % of the whales in the middle estuary. Structural components of the habitat and different social requirements were hypothesized as important determinants of the dynamic structure and segregation pattern. This first analysis used simple and functional definitions of grouping independant of filiation or associations over extended periods of time. An ongoing long term study using photo-identification suggests site fidelity and the persistence of individual associations. Results from this program and application of new molecular techniques are needed to go beyond structural analyse into the study of social organisation.

STRANDING AND MORTALITY ASSESSMENT OF MARINE MAMMALS IN PUERTO RICO AND THE VIRGIN ISLANDS.

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Although the presence of marine mammals has been documented and studied in Puerto Rico and the Virgin Islands, there is a lack of information on factors which affect their survival in the northeastern Caribbean. In particular, the mortality and strandings of these creatures were not directly addressed previously, despite that over 140 marine mammals were found stranded on shore or killed in the past four decades. To assess mortality and stranding factors in the area, a study was conducted analyzing data from historic cases dating between 1937 and 1985, and study cases dating between 1985 and 1993. A total of 148 cases of 16 different species of cetaceans and sirenians were analyzed for frequency distribution of eight factors, including species, locality, seasonality, year, month, gender, size class, and cause of death. The analysis clearly showed that manatees are the most commonly found marine mammal stranded or dead, accounting for over 31 percent of all cases. A large incidence of undetermined cause of mortalities for all species clearly indicated that numerous historic cases were not thoroughly documented or examined. Where the cause was known, these were most often the result of human activity. Of the determined cause of death in manatees, more than half were due to human interaction (poaching or vessel collision), while on cetaceans, human interaction cases were minimal, most being due to natural illness.

DIALECT DEVELOPMENT IN ORCINUS ORCA

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Dialects between pods are known to occur in wild populations of Orcinus Orca but the source of this variation is poorly understood. In this study the vocalizations of the 3 maternal subgroups within the A1 pod were compared. Over 18 hours of vocalizations recorded from 1979 to 1985 in the presence of a solitary subgroup were analyzed. 1,784 calls were identified and the structural elements of 489 calls were measured. Significant variation between the subgroups was observed in both call usage patterns and call structure. Variation in usage patterns resulted from differing use of shared calls and the existence of a call used almost exclusively by one subgroup. Variation in structure was observed in both duration and frequency parameters. Descriminant function analysis determined that the most significant variation was in the terminal component and the upper frequency component of each call. 59% of the components which varied significantly within pod A1 also vary significantly between pods A1, A4, and A5 (77.5% for terminal components). Similarity indexes for both call usage and structure closely match association indexes between the three subgroups suggesting that vocal differentiation is a correlate of relatedness between subgroups. This study provides evidence for dialect development through two mechanisms: the gradual evolution of calls into subtypes, and the occasional generation of new calls.

PERIPHERAL TISSUE COMPOSITION AND ITS IMPACT ON HEAT LOSS IN THE WEST INDIAN MANATEE (*Trichechus manatus*)

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Due to a strong correlation between decreased air and water temperatures (as a result of cold fronts) and increased mortality rates of the West Indian manatee (*Trichechus manatus*), insulative properties of the dermis, blubber and muscle layers were investigated. Axillary dorsal, lateral, and ventral samples were obtained, from animals salvaged throughout Florida, and analyzed for lipid content and conductivity (the inverse of insulation). Analyses showed that the dermis was 0.3 ± 0.5% lipid (wet weight) (n=25), the outer blubber layer (bA) was 63.6 ± 19.5% lipid (n=24), the outer muscle layer (mA) was 0.3 ± 0.5% lipid (n=21), and the inner blubber layer (bB) was 61.3 ± 18.7% lipid (n=15). Conductivity of manatee dermis was 0.21 ± 0.07 $Wm^{-1}°C^{-1}$ (n=14), bA was 0.13 ± 0.04 $Wm^{-1}°C^{-1}$ (n=13), mA was 0.28 ± 0.10 $Wm^{-1}°C^{-1}$ (n=4), and conductivity for bB was 0.14 ± 0.04 $Wm^{-1}°C^{-1}$ (n=3). Conductivity varied inversely with lipid content. When measured intact, conductivity ranged from 0.29 ± 0.02 $Wm^{-1}°C^{-1}$ (n=6) to 0.34 ± 0.06 $Wm^{-1}°C^{-1}$ (n=5) for samples consisting of only dermis and bA or dermis, bA, mA and bB, respectively. Although lipid content and conductivity values for blubber are similar to those of many cetacean species, it appears that manatee insulative quality is generally poor due to the negating properties of the skin and muscle layers.

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PHYLOGENETIC RELATIONSHIPS OF EXTANT CETACEANS BASED ON MULTIPLE DNA SEQUENCE DATA.

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DNA sequence analyses of two mitochondrial ribosomal gene segments (12S and 16S) for multiple representatives of most major groups of cetaceans and 4 outgroups recently suggested that Odontoceti and Mysticeti did not have long independent histories (Milinkovitch et al. 1993). In particular, the sperm whales (Physeteroidea) were found to be more closely related to the mysticetes than to other odontocetes. Here, we further analyze this hypothesis by using DNA sequences from a third mitochondrial gene segment, the cytochrome b, for all major groups of cetaceans and by extending the 12S and 16S DNA dataset. The three gene fragments (1350 bp per species, 21 cetacean species plus multiple outgroups) support the baleen-sperm whale sister relationship we proposed previously and provides resolution for most of the interfamily relationships. The implications of this phylogenetic hypothesis for rates of evolution and morphological homoplasy are discussed.

DISTRIBUTION AND GROUP SIZES OF THE ATLANATA SPOTTED DOLPHIN (*STENELLA FRONTALIS)* IN THE GULF OF MEXICO

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Opportunistic sightings of the Atlantic spotted dolphin were recorded by trained observers over a four year period (1988-1992) on the continental shelf in the Gulf of Mexico. These observations included data on herd size, behavior, depth, sea surface temperature, time of year and position, and were collected during NMFS resource surveys aboard the NOAA ships *Oregon II* and *Chapman*. Analysis of the data revealed a weak correlation between depth and number of animals sighted with the majority of sightings (70%) located in waters less than 55 meters ($\bar{x}$ = 59, S.E. = 4.1). No significant correlations exist between sea surface temperature or longitude and number of individuals observed. Herd sizes ranged from 1-65 individuals per sighting (n = 77) and the mean herd size equaled 10 (S.E. = 1.1). There was a marked increase of sightings per unit effort during the spring months (March - May). Depth or, perhaps, bathymetry may influence the distribution of the Atlantic spotted dolphin. This report represents the largest database, to date, on the Atlantic spotted dolphin in the Gulf of Mexico.

TWO SPECIES OF "MINKE WHALE" MAY CONFOUND WHALE CONSERVATION

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The vernacular name "minke whale" is a whaler's term for the smallest North Atlantic rorqual, *Balaenoptera acutorostrata acutorostrata*. The term's use for southern hemisphere forms dates from the 1960s when small rorquals were first commercially exploited in that area. A North Pacific subspecies, nominally *B. a. davidsoni*, is now termed the minke whale. There is evidence of a third unnamed subspecies of *B. acutorostrata* in the southern hemisphere, a diminutive or dwarf minke whale differentiated from the two northern subspecies by biochemical, genetic, pigmentation, morphometric and other data. Catches of it have been less than 5% of southern hemisphere "minke whale" commercial takes.

Current discussions of research and commercial whaling of minke whales confuse distinctions between two species of small rorquals, especially in comparisons of smaller northern populations to a larger southern population of "minke whale". The abundant southern "minke whale" with no vernacular name is a separate parapatric species, *Balaenoptera bonaerensis*, distinguished from *B. acutorostrata* by size, pigmentation, biochemical and genetic evidence and differences in biological parameter values. The International Whaling Commission's Schedule formally defines for management purposes "minke whale (*B. acutorostrata, B. bonaerensis*)". Rational cetacean conservation requires management of clearly defined populations and taxonomic entities. Future research or commercial exploitation of southern "minke whales" will not be rational if two species are managed as one. In a fishery taking mainly *B. bonaerensis*, small takes of the much less abundant *B. acutorostrata* could adversely affect its population.

AERIAL SURVEYS OF HUMPBACK WHALES WINTERING IN HAWAIIAN WATERS: 1993 RESULTS

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Previous shipboard and aerial censuses of humpback whales wintering in the waters surrounding the major Hawaiian islands were primarily limited to nearshore waters within the 100-fathom contour. The assumption that humpbacks were nearly exclusively found in these depths was not systematically tested until this effort. During the 1993 winter season, aerial surveys were flown along north-south transect lines extending 7 nm past the 1,000 fathom isobath in each direction across a four-week period from Feb. 22 to March 25, 1993. Each area was surveyed four times at approximate one-week intervals using random start points. Flights were performed using two Cessna 172 overwing aircraft, each outfitted with a GPS receiver and radar altimeter in addition to conventional navigational avionics. Sightings were made by two observers, one on each side, and recorded by a data recorder. Distances to each sighting were estimated using the radar altimeter and hand-held clinometers. Location data was acquired directly from the GPS. Effort by depth was distributed as follows: 20.2%, 43.4%, and 36.4% for waters within the 100, 1000, and 1000+ fathom isobaths respectively.

The peak sighting rate for all regions combined was recorded on the second flight (March 15-16). A total of 406 humpback whale pods were observed across all flights with an average of 1.68 whales per pod. 82% of the these sightings occurred within the 100 fathom isobath, with 16% and 2% occurring within the 1000 and 1000+ fathom areas respectively. These represent significant departures from expected frequency proportionate to effort [chi-square(2) = 960.1, p<.0011]. The fact that 18% were sighted in waters greater than 100 fathoms suggests that previous census attempts may have under-estimated the wintering population. Analysis of encounter rates (whales/hr) across five island regions showed greatest densities at Penguin Bank (27.0), followed by Four Island Region (13.0), Kauai/Niihau (9.6), Big Island (3.8), and Oahu (3.0).

VARIATION BETWEEN SURVIVAL RATES OF SEA OTTER PUPS: BIOLOGY OR METHODOLOGY?

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Differences in the status of sea otter populations relative to their prey bases could explain recently observed higher rates of pup survival in Alaska versus California. However, differences in pup survival rates between Alaska and California could also be due to variation in other biological phenomena or to differences in the assumptions made in survival rate estimation.

Data from radio-instrumented sea otters in Prince William Sound (1987-1991) indicated that 63%-90% of the pups born each year survived to weaning. The probability of survival of pups in Alaska was found to vary with the age of the pups, the age of the mother and the time of year of birth.

Assumptions about the minimum age at which pups can be successfully weaned, as applied to analyses of telemetry data, have varied between studies in Alaska and California (90 versus 150 days, respectively). For instrumented sea otter pups in Alaska, no correlation existed between the pups' ages at weaning (if > 89 days old) and the probability of their surviving the subsequent 6 months. Similar data from California is needed before comparisons can be made with Alaska.

DEVELOPING A CATEGORICAL PHOTO-IDENTIFICATION COMPUTER SYSTEM

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Longitudinal studies focus on long-term identification of individual animals, sometimes based on discrete differences in natural markings. With small groups of animals, individuals can sometimes be recognized from hard-to-quantify characteristics, such as a person's ability to recognize faces. With larger groups of animals, categorical systems of recognizable features can help identify large numbers of individuals quickly. We describe the evolution, testing and refinement of a categorically-based computerized photographic system used to identify humpback whales based on photographs of their tail flukes.

A set of 54 fluke pattern types was developed based on categorical criteria and patterns seen in existing photo-identification catalogs. A reference set of 25 fluke photographs (representing 23 individual whales) was used for a series of tests of 25 independent readers. The 14-sector Balcomb/Katona fluke map was reduced to 10 sectors for the tests. The prototype system also included a category for using ratios of counts of points on the trailing edge of each fluke.

The prototype system was presented for evaluation at a humpback whale photo-ID workshop in April 1986. Based on workshop results and further tests, the patterns were reduced to 36 types and the 10-sector fluke map was restored to the original 14-sectors. The category based on counts of trailing edge points was omitted, due to reader inconsistency, and a category based on medial notch shape was added.

In 1991, patterns used for the 9,300 photographs in the North Pacific database were evaluated and error-checked. Thirteen "white trailing edge" patterns were omitted and 8 "miscellaneous" patterns were added, for a total of 31 types.

For very-to-moderately distinctive animals, computer-assisted matching produced matches after comparison with 1-2% of the database. For individuals with few distinctive features, matches were found after comparison with about 3% total.

OBSERVATIONS ON BEHAVIOR AND ECOLOGY OF BOTTLENOSE DOLPHINS, TURSIOPS TRUNCATUS, IN THE ESTUARY OF THE PATOS LAGOON, SOUTHERN BRAZIL.

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Between May 1992 and June 1993, 23 boat-based surveys were conducted over 275km^2 in Patos Lagoon (32°S, 52°W) estuary, southern Brazil, in order to study the ocurrence and activity patterns of bottlenose dolphins.

Throughout the year, dolphins were most frequently observed close to the estuary mouth. According to the abundance of potential prey and physiographic features, they showed distinct activities in different places. They usually travelled in waters deeper than 6m, following a depth contour characterized by a steep slope (3 to 6m) or in the harbour channel about 14m deep. They fed in waters varying from 2 to 22m of depth, presenting different patterns of surface behavior which depended on the prey species taken. During summer and fall they often hunted mullets, Mugil platanus, in waters shallower than 6m and, during winter and spring they preyed mainly on bottom fishes in the channel, where also travel feeding occurred. Socialization was common in shallow as well as in deep waters and resting was observed primarily in shallow protected areas.

Based on direct counts an estimated maximum number of 42 (α=0.05) bottlenose dolphins used simultaneously the estuary. A catalogue of photoidentified animals was commenced with a total of 31 individuals recognized. Frequent resightings of several specimens suggest a permanent residence.

RESPIRATION AND SWIM RATES OF A STRANDED RISSO'S CALF

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A female Risso's dolphin (*Grampus griseus*) calf stranded on Padre Island, TX on April 24, 1993. The animal is only one of three known strandings of Risso's dolphin along the Texas coast since 1980, and the only known live calf to be recovered. It was recovered by the Texas Marine Mammal Stranding Network, and stabilized at the Texas State Aquarium, Corpus Christi, TX. The calf was subsequently transported to Sea World of Texas. Upon arrival, the calf weighed approximately 25 kg at a length of 1.3 m. Because of the presence of fetal folds and hair follicles along the rostrum, the calf was determined to be 3-5 weeks old. By July 1993, she weighed 55 kg. The purpose of our study is to track the behavioral development of this young dolphin in the absence of conspecifics. Recordings were collected via a Canon L1 Hi8 video camera and a Brüel and Kjaer hydrophone (type 8104) and charge amplifier (type 2635). Preliminary analyses consisted of five recording days (Trips: B-F) from April - July 1993. Each recording day consisted of four-one hour sessions: midnight, dawn, noon, and dusk. Fifteen minute subsets of each session were used for preliminary data analyses. ANOVA of Inter-Blow-Intervals (IBI) resulted in a significant difference between Time of Day (TOD; $p = .0005$), Trip ($p < .0001$), and TOD by Trip ($p < .0001$). Mean IBI from TOD by Trip ranged from 8.9 - 18.3 sec. Blow rates (BR) were calculated for each session. Swim rates (SR) were also calculated by recording the distance swum (circumference) along the edge of a pool ($r = 3.04$ m) for each session. Kruskal-Wallis tests indicated a significant difference in BRs across Trips ($p = .0379$), yet no significant difference across TOD ($p = .7021$). No significant differences in SRs across TOD ($p = .1725$) or across Trips ($p = .4827$) were detected. Preliminary analyses indicated a positive relationship between SR and BR, with ranges of 0.29 - 0.93 m/sec, and 3.3 - 6.4 blows/min, respectively. Further data analysis of this rare occurrence will allow for a more detailed description of physiological, acoustic, and behavioral development.

THE ECOLOGICAL IMPACT IN PILOT WHALES PRODUCED BY BOATS

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The presence of a resident population of short-finned pilot whale ***Globicephala macrorhynchus*** near of the SW coast of the Tenerife island, has provoked the proliferation of whale-watchers boats.

The aim of this study was to determinate the area of distribution and area use, as also the ecological impact in pilot whales produced by these boats.

This program was carried out from June to December of 1992. The distribution area was divided in high, medium and low use subareas in funtion of both the number of encuenters and transects we made, observing significative differences in the mean dephts (Kruskal-Wallis H = 9.021 df = 2 p = 0.01). The analysis of the monthly variation of the sighting rate (SPUE) showed a high number of encuenters among July and October (Kruskal-Wallis H = 2.98 df = 7 p = 0.05).

The analysis of the respiratory intervals show differences in their lenght in relation to the presence of absence of boats.

DETERMINATION OF HEALTH AND STATUS OF CAPTIVE AND SEMICAPTIVE ANTILLEAN MANATEES, *TRICHECHUS MANATUS MANATUS*, IN COLOMBIA

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No systematic surveys of Antillean manatee, *Trichechus manatus manatus*, have been conducted in Colombia. This species is in danger of extinction in this country primarily because of hunting. Since 1989, Caribbean Stranding Network's (CSN) participants have been involved in the rescue of manatees, creating three protected semi-captive colonies in artificial lakes where the animals are safe from poaching in Colombia. A necessity exists for basic information about manatee hematology to improve the husbandry of these and other Colombian manatee populations. The assessment of the status and health of the semi-captive manatee population was conducted between 21 June and 8 July 1992. Interviews relating to the capture of the manatee, external examination, morphometrics and blood samples were taken from 21 semi-captive or captive manatees according to the standard methodology from the Fish and Wildlife Service's Forensic Laboratory and Sirenia Project. Twenty three different serum chemicals (liver, muscle and kidney associated enzymes, bilirubin, glucose, lipids, pancreatic enzymes, proteins and electrolytes) were analyzed. The reference ranges for the serum chemical values were determined using Dixon statistical test with a 95% confidence level. External examination and results of blood analysis revealed that most of the manatees were in good health, except for an animal kept at the Barranquilla Zoo since August 1989. This animal probably presents decreased osteoblastic activity and inbalance of electrolytes given by low values of sodium and low normal values of amylase. This condition is probably due to a deficient nutrition and an unhealthy environment. Moreover, the animal is confined in a small shallow pool unable to swim and properly grow. According to these results, the immediate move of this animal to one of the CSN-sponsored semi-captive colonies was recommended. Probably, the best indication of the excellent conditions of space, nutrition, and protection of the established semicaptive colonies was the birth of two manatees in two of the colonies during the summer of 1992.

UNPRECEDENTED SUCCESSFUL REHABILITATION OF AN ORPHANED ANTILLEAN MANATEE (*TRICHECHUS MANATUS MANATUS*) IN THE NORTHEASTERN CARIBBEAN

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Successful rescue and rehabilitation of manatees in Florida has occurred for several years, however, when a one week old manatee calf stranded in 1991 in a sewer canal in Puerto Rico, the Caribbean Stranding Network successfully attempted the first rescue, rehabilitation, and release of a manatee in the Northeastern Caribbean. The male manatee became a catalyst for the collection of essential scientific information regarding blood analysis (biochemistries and complete blood counts), immunoglobulin studies via eletrophoresis, morphometrics, diet, behavior, and effective therapeutic protocols. In addition, his rescue served as a launch for further data collections (blood and morphometrics) of the native manatees in the waters surrounding Puerto Rico.

WHISTLES PRODUCED BY COMMON DOLPHINS FROM THE SOUTHERN CALIFORNIA BIGHT

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A total of 5,291 whistles produced by common dolphins, *Delphinus delphis*, from the Southern California Bight were analyzed by digital processing of spectrograms and categorized to eight whistle-types, four of which comprised over 97% of any sample. The eight whistle-types were similar to, but not inclusive of all, whistle contours previously reported for common dolphins offshore California, indicating that the whistle repertoire for the species is larger than that reported here. The authenticity of the whistle-types is supported by their occurrence in each of four recording contexts, although proportions of the dominant four whistles varied among contexts. Because the common dolphin whistles described here were not individual-specific nor context-specific, they seem best characterized as a portion of either a graded series or regional dialect repertoire.

THE SURVIVAL AND MOVEMENT OF REHABILITATED HARBOR SEAL PUPS

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The Marine Mammal Center recovers, rehabilitates and releases stranded marine mammals along the central and northern California coast. In this study rehabilitated harbor seal pups were tracked utilizing flipper mounted radio tags. Nine seals in both 1991 and 1992 (n=18) were studied to evaluate their post release survival. Seals were monitored using stationary field receivers, aerial overflights, and shore based observers. At least 7 of the 18 seals survived the first 100 days after release, of these, 5 seals returned to the release site at least 160 days following release. The longest period of time an individual seal was tracked following release was 186 days. Only one seal was found dead (60 days after release).

Five seals were relocated at locations other than the release site. Of these the furthest distance from release to resight was 175 km (88 days after release). There was variation in individual behavior; one seal left the release site after 7 days and was not located again, while another seal was recorded at the release site for 30 consecutive days before leaving. Based on survival after 160 days, these results indicate that at least 28% of rehabilitated harbor seals over this two year period were able to sucessfully return to the wild. This relocation rate is an improvement over visual resightings which only accounted for 12% of released harbor seals.

AN UNRECORDED COLONY OF STELLER'S SEA LIONS NEAR FORT ROSS, CALIFORNIA

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Sea Lion Rocks (Lat. 38°30' 0"W, Long. 123°15'40"N), 2 km west of Fort Ross, California, form an unrecorded Steller sea lion rest area and rookery. Although state parks rangers and local residents have long known that sea lions haul out on these rocks, no one appears to have realized that the rocks were also a rookery for the endangered Steller sea lion. The rocks are not photographed or counted during the annual California Fish and Game census, nor were they included in Loughlin, Perlov, and Vladimirov's (1992) summary of world Steller population. Four previous censuses, the latest in 1982, have recorded Steller sea lions at Fort Ross Reef, which lies 3.5 km to the southeast. No Stellers were observed on the Reef during the present study.

Both Steller sea lions and California sea lions visit the Sea Lion Rocks. The numbers of Steller sea lions vary with sea conditions and averaged 17.8 during the three years of observations reported here. The highest count of Steller sea lions was 28; the maximum number of pups counted was 14. However, since it is not possible to accurately count rafting animals, the maximum recorded and average calculated values may be underestimates. Also, under very calm sea conditions, Stellers haul out on the lower face of South Sea Lion Rock, which is only partly visible to the observer on the sea ledges. Counts of this rock in mild weather can be difficult, and may also be underestimates.

There is little variation in Steller numbers over the year compared to that in California sea lions. The number of California sea lions recorded grew nearly twentyfold during the three years of observations, reaching a maximum of 463 in June 1993. However, high numbers of Californias are seen only in late spring and early summer. Many of the California sea lions are small animals, and their presence at Fort Ross seems to be linked with the El Niño. During most counts at Fort Ross, no Californias were visible.

OCCURRENCE OF NORTH ATLANTIC RIGHT WHALES (EUBALAENA GLACIALIS) IN RELATION TO GEOPHYSICAL FEATURES OF THE SCOTIAN SHELF

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The Right Whale Recovery Plan lists as one of its main objectives the "identification and protection of habitats essential to the survival of the northern right whale". It is still unknown where some portions of the population migrate during the winter and new genetic evidence indicates an additional summering ground, possibly near Greenland. During the summer and early fall, right whales are concentrated in the Gulf of Maine, in the Bay of Fundy, and on the Nova Scotian shelf near Browns and Baccaro Banks.

Methodology for this study involves plotting right whale sightings data, sea surface temperature (NASA JPL data in 18km^2 pixels, monthly from 1978-86), bathymetry, and currents in overlaying coverages using the ARC/INFO program. This analysis will look for broad seasonal patterns; the sightings database is accurate to one square nautical mile. Multivariate discriminant analysis will determine if there is a statistically significant relationship between where right whales are found and concurrent geophysical features.

By looking at intensive areas of known occurrence such as the Browns/Baccaro Banks region, we can use the discriminant function to classify right whale habitat and predict the likelihood of right whale habitation in uninvestigated areas of the northwest Atlantic. The result of this study will allow us to incorporate factors such as food production and other biotic activity into a GIS system to determine environmental changes that influence right whale occurrence.

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INDEPENDENT FORAGING BY RECENTLY WEANED HARBOUR SEAL PUPS

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The development of independent foraging is a crucial part of the transition between lactation and independent feeding. Efficient diving and foraging skills are essential for pup survival especially during the early stages of the life cycle. We monitored changes in body mass and the onset of foraging activity of recently weaned harbour seal pups, Phoca vitulina, from June 7 to July 28, 1993, on Sable Island, Canada. Known age pups were captured, weighed and bled to assess the opacity of blood serum at weaning, and recaptured at 7-10 d intervals for an additional 3-4 week period. Time depth recorders were attached to 8 pups shortly after weaning and removed 21 to 29 d post-weaning. Dive behaviour was recorded for an average of 22.3 ± 2.5 days with total number of dives ranging between 4254 and 7724. Mean dive duration was 1.75 min at 5 d post-weaning (dpw) increasing to 2.24 at 21 dpw. Mean dive depth was 13.17 ± 7.60 m with a maximum of 51 m. Bottom time also showed an increase from 0.94 min at 3 dpw to 1.5 min at 21 dpw, while surface time decreased from 2.45 min to 1.79 min over the same interval. Despite the diving/foraging activity, pups lost on average 11% of their weaning mass over a 25 d period, thus suggesting that the amount of food consumed during this period is not sufficient to offset the costs of initial foraging activity. The diving behaviour of harbour seal pups resembles that of female harbour seals during the initial stages of lactation, although in a smaller scale, suggesting that the pups have the same physiological constraints to diving and foraging activities as adult females. Given the fact that a similar pattern had also been reported for northern elephant seal pups, Mirounga angustirostris, we suggest that the diving behaviour and foraging skills of young phocids already reflect the physiological constraints of each species.

DETERMINATION OF BLUBBER AND SERUM ORGANOCHLORINE LEVELS IN DISEASED AND HEALTHY JUVINILE NORTHERN ELEPHANT SEALS (*MIROUNGA ANGUISTIROSTRIS*)

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Organochlorine (OC) levels were measured in adipose biopsies (~10 mg) and serum (~2 ml) from yearling northern elephant seals (*Mirounga anguistirostris*) during the investigation of a skin disease which effects juveniles in the California population. The analytical procedures utilized were scaled down modifications of accepted methods and withstood rigorous QA/QC validations. Documentation of the usefulness of exceedingly small sample sizes for the study of wild populations was a primary goal of this phase of the investigation.

Samples were collected from fasting juveniles during the 1992 spring molt. Healthy individuals, nine females and five males, were sampled at the Año Nuevo, CA rookery while diseased individuals, six females and four males, were sampled during rehabilitation at The Marine Mammal Center.

OCs decreased in all animals in the order DDTs > PCBs > Chlordanes. ΣDDTs:ΣPCBs were 3:1 and 2:1 for blubber and serum respectively. ΣDDTs:ΣChlordanes were 8:1 in either matrix. The geometric means for ΣDDTs in the diseased vs. the control groups were 1460 and 695 ug/wet kg respectively in the blubber and 40.7 and 10.4 ug/wet kg respectively in the serum. No gender related trends were observed.

Adipose tissue OC levels were positively correlated with serum concentrations ($K = 0.679$, $Z = 4.19$; $p < 0.01$). Adipose OC concentrations in diseased and healthy seals could not be differentiated by Mann-Whitney U-tests ($p > 0.05$). Serum OC concentrations, however, showed very significant differences ($p < 0.005$).

DEVELOPMENT OF DIVING BEHAVIOR OF WEDDELL SEAL (*LEPTONYCHOTES WEDDELLII*) PUPS.

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During the austral spring and summer of 1992-1993, at McMurdo Sound, Antarctica, 17 Weddell seal pups and 8 yearlings were outfitted with time depth recorders (TDRs) to monitor the development of diving behavior as age increased. Pups between the ages of 2 and 14 weeks carried TDRs biweekly for 3 day periods, while yearlings carried TDRs once for a period of 5 days. To track dive behavior throughout the fall and winter, 0.5 watt Satellite-linked time depth recorders (SLTDRs) were deployed on 7 pups. TDR and SLTDR dive data were combined when possible, yielding dive records up to 9 months in length for pups. Only dives greater than 12 meters deep were analyzed. Pups began to dive within their first 2 weeks, and the number of dives per day, the mean dive duration and depth, and the maximum depth and duration of dives per day increased significantly as the pups aged. During their first 14 weeks, pup dives increased on average 5.85 meters and 22 seconds a week, and reached depths and durations approximately half that of yearlings. Pup diving frequency increased weekly by approximately 3 dives a day, and in late summer, surpassed that of the yearlings tagged in spring. Maximum diving ability of the pups was determined from the deepest and longest dives in each day. Maximum duration of pup dives increased by an average of 55 seconds per week between the ages of 2 and 14 weeks, and peaked at approximately 10 minutes. Yearling maximum durations averaged about 18 minutes. Maximum depth records were augmented with SLTDR data and revealed a steady increase in depth of dives by almost 14m a week throughout the length of the record. Pups diving in the fall occasionally dove deeper than did the yearlings. These results show that Weddell seal pups are able to dive soon after birth, and do so as frequently as yearlings by the time they are 2 months old. Yet, the pup's ability to dive to depth approaches that of yearlings sooner than does their ability to remain submerged, suggesting that pup diving behavior is more limited by duration than by depth constraints.

OCCURRENCE, BEHAVIOR AND GROUP SIZE OF MINKE WHALES IN CAPE COD AND MASSACHUSETTS BAYS

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Sighting data from a total of 10,249 cruises from commercial whalewatching and research vessels were used to examine temporal occurrence, behavior and group characteristics of minke whales, *Balaenoptera acutorostrata*, for the years 1979-1992 in Massachusetts and Cape Cod Bays (an area in which this species has been previously unstudied).

A total of 6,266 minke whale sightings were made during the study period, with significant inter-year variation. Minkes were commonly observed between March and October and in some years were seen as late as December. The data indicate a distinct peak in abundance between July and September with minkes becoming scarce or absent during autumn and winter. This general pattern of occurrence is similar to that reported for other high-latitude minke populations and may reflect a migration of most minke whales to lower latitudes during the winter.

Only three calves were sighted during this study, suggesting either that minkes wean their calves prior to arrival on the feeding grounds or that populations exhibit segregation by maturational or reproductive class. Observed group size frequency was: singletons (95.4% of sightings), pairs (3.8%), and trios (0.8%). With the exception of a single group of five whales, no associated groups larger than three were observed. Surface feeding was rarely observed (0.4% of sightings), as was breaching (0.7% of sightings); curious approaches to vessels constituted 1.5% of sightings. Overall, the data from this study area are generally similar to those reported for minkes from the high-latitude regions of other oceans.

ECHOLOCATION BY KILLER WHALES (ORCINUS ORCA) WHILE IN PURSUIT OF LIVE FISH

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Echolocation use by cetaceans has been postulated to be functional in a natural environment, but might not be used as frequently in a captive setting where the water is clear and the whales are hand-fed. The object of this study was to see if captive Orcinus orca used echolocation when presented with live fish. We fed live coho salmon (Onchorhynchus kisutch) to two captive killer whales at Marine World Africa, U.S.A., Vallejo, CA. The experiment was videotaped and recorded on a high frequency Racal 4D store four-track tape machine at 30 inches per second. A hydrophone array, consisting of a B&K 8104, a B&K 8105 and a Magnavox, was used to receive the sounds. Recordings of echolocation clicks were slowed down and analyzed with a Kay Elemetrics DSP 5500 Sonagraph and a MacAdios sound analyis program.

Results of this study demonstrate that captive killer whales will pursue, capture, and eat live fish. The whales in this study used echolocation while in pursuit of fish, as well as at other times. Preliminary analyses of echolocation clicks reveal spectral energy up to 80 kilohertz.

LISTERIA IVANOVII INFECTION IN FIVE PHOCID PUPS

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Listeria ivanovii has been isolated post mortem from 3 Pacific harbor seals (*Phoca vitulina richardsi*) and a northern elephant seal (*Mirounga angustirostris*) and ante mortem from a harbor seal at The Marine Mammal Center since 1990.

Case 1: a 10 day old harbor seal developed severe secretory diarrhea and died 9 days later of *E. coli* septicemia with suppurative omphalitis from which *L. ivanovii* and *Enterococcus zymogens* were cultured. The pup also had hepatic and adrenal necrosis attributable to herpes virus. Case 2: a bone sequestrum was surgically removed from a harbor seal pup with a draining tract in the tarsus and *L. ivanovii* was isolated in pure culture. The animal was released 3 months later after debridment and treatment with enrofloxacin. Case 3: a 4 day old harbor seal was euthanatized due to a lack of deep pain sensation in the rear flippers. *L. ivanovii* and *E. coli* were isolated from multiple tissues. Case 4: a 2 month old weaner northern elephant seal died 2 days after admission from DIC related to *Erysipelothrix rhusiopathiae* septicemia. *L. ivanovii* was isolated from a hypodermal abscess along with large numbers of beta hemolytic *Streptococcus sp.*, and small numbers of *E. coli* and *Staphylococcus sp.*. Case 5: a 7 day old harbor seal died after 3 days of severe diarrhea. *L. ivanovii* was cultured from the lung, mesenteric lymph node and liver. *E. coli* and *Enterobacter sp.* were also isolated from the lung and liver.

In only 1 of the 5 cases was *L. ivanovii* the only pathogen cultured. The role of *L. ivanovii* as a primary pathogen in marine mammals is unknown but it is a known cause of abortion in sheep and cattle. Since it can also infect humans, caution should be exercised by persons in handling live or dead pinnipeds.

EARLY DEVELOPMENT OF HUMORAL IMMUNITY IN NORTHERN ELEPHANT SEAL, *Mirounga angustirostris*, NEONATES

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Epizootics occurring among pinnipeds, such as phocid distemper virus, and the recent decline in worldwide seal populations has focused attention on the scant information concerning immune systems of marine mammals. Northern Elephant Seal (NES) pups are exposed to a variety of potentially dangerous marine and terrestrial antigens, yet NES's have not experienced a serious epizootic. This observation led us to study the NES humoral immune system. Repeated serum samples from individual pups were collected from birth to 6 weeks of age on Año Nuevo Island. NES IgG was isolated from serum by Protein A chromatography for use as a standard and concentrations of IgG were determined by Bradford assay. Purity was determined by SDS-PAGE. Concentrations of IgG from raw serum were determined using enzyme linked immunosorbent assay (ELISA). Heterologous antisera (anti-canine IgG linked with peroxidase) that cross-reacted with NES IgG as determined by radialimmunodiffusion (RID) and immunoelectrophoresis was used to detect the relative changes in the level of IgG over the several weeks of sampling. Results indicate that serum IgG increased linearly nearly five-fold during the first six weeks of life ranging from 3.00± 0.43 mg/ml (≤1 day) to 16.21± 2.93 mg/ml (week 6). Immunoglobulin levels detected at ≤1 day are comparable to other neonate marine mammals as well as non-ruminant terrestrial neonate mammals suggesting either placental transfer, or in-utero synthesis of immuno-globulins or both. Currently we are developing an anti-NES IgG antisera for use in future ELISAs. Supported by NIGMS-MARC GM07910(CLO).

THE ACOUSTICS OF ODONTOCETE CETACEAN SIGNALS RECORDED IN THE NORTHWESTERN GULF OF MEXICO.

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Tape recordings were made in the presence of thirteen of the 21 odontocete cetacean species found in the Gulf of Mexico. These recordings were made during five GulfCet cruises using a towed linear array with a bandwidth, in normal operating conditions, of 5 Hz-15 kHz. These recordings were made in the Northwest Gulf of Mexico along 14 north-south transect lines 40 nm apart between the Florida-Alabama border and the Texas-Mexico border between the 100-2000m isobaths. Of the fourteen delphinid species potentially present we recorded all but three, lacking only *Orcinus orca*, *Feresa attenuata*, and *Grampus griseus*. This list includes some of the first recordings from the Gulf of Mexico of *Lagenodelphis hosei*, *Peponocephala electra*, *Steno bredanensis*, *Stenella clymene*, *S. longirostris* and *S. coeruleoalba*. Additional species include *Pseudorca crassidens*, *Globicephela macrorhynchus*, *Tursiops truncatus*, *S. frontalis*, and *S. attenuata*. We have no confirmed recordings from any ziphiid or physeterid other than the sperm whale. Results of acoustic analyses of these species whistles, burst pulses, and in the case of the sperm whale, their pulses are presented. Each species' recorded signals are described using a series of acoustic parameters in both the frequency and time domain.

OBSERVATIONS OF BEAKED WHALES (*MESOPLODON SP.*) IN THE WESTERN NORTH ATLANTIC OCEAN

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The genus Mesoplodon comprises nine species of which the distribution and abundance, both spatially and temporally, is poorly understood. Until recently most of the data gathered relative to their distribution and abundance has been derived from stranding records. Since 1989 the Northeast Fisheries Science Center at Woods Hole, Massachusetts has been conducting dedicated marine mammal sighting surveys in the western North Atlantic Ocean. The surveys have concentrated in waters on the Continental shelf break and slope from east of North Carolina to the Scotian Shelf. During the most recent survey, June 1 through July 2, 1993 several *Mesoplodon sp.* sightings were photographed at close range. On at least two occasions, female groups were photographed with calves. The general behavior of the animals varied greatly both by species and sex.

SATELLITE TRACKING OF CRABEATER SEALS OFF QUEEN MAUD LAND IN ANTARCTICA.

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The crabeater (*Lobodon carcinophagus*) is the most abundant seal species in the world, but still very little is known about the distribution and feeding ecology throughout the year. In late February 1993, during the Norwegian Antarctic Research Expedition (NARE1992/93), eight crabeater seals (3F, 5M), ranging in body mass between 125 and 220 kg, were captured off Queen Maud Land (70-72 °S, 7-16° W) and tagged with 0.5 W Wildlife Computers SLTDR Argos satellite transmitters. The transmitters provide location, diving frequency, diving depth and diving duration. During the first few weeks after moulting in mid-February the seals stayed in the drift-ice, doing excursions along the continental shelf edge. During this period diving was as frequent as ~150 dives/day. During late April and May most seals migrated northwards, out in deep waters, reaching as far as 63° S, before returning southwards in early June. Also during this period diving was maintained at a high level, indicative of active feeding. Maximum distance covered by a single seal between 22 February and 15 June was 3875 km. In the same period maximum diving depth varied between 232 and 528 m between individuals. Most dives, however, were of short duration (< 2 min) to depths less than 50 m. This may indicate that the crabeater seal continue to feed on krill when winter returns in Antarctic waters. We moreover suggest that seasonal movements by crabeater seals as determined by satellite tracking may be a method to assess the seasonal distribution the Antarctic krill.

Effects of broadband boat noise on the acoustic behavior of singing humpback whales (*Megaptera novaeangliae*) off Kauai, Hawaii.

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Many researchers have investigated effects of vessel traffic on cetacean behavior, however, few have addressed acoustic behavior. I examined the effects of boat noise on humpback whale singing behavior by experimentally introducing noise from a small vessel. The objective was to determine if high levels of boat noise result in changes in song signals or patterns. In winter-spring 1991 and 1992, songs of 18 humpback whales were recorded during experimental boat passes in coastal waters off southern Kauai. Additionally, songs of 8 animals were recorded opportunistically during passes of large vessels (10 m to 50 m). Over 35 hours of recordings suitable for analysis were made. The recording system was fully calibrated so that absolute received sound levels could be determined. Recordings were analyzed using SIGNAL, a DOS based DSP program. Forty quantitative acoustic variables (e.g. duration, avg./min./max. frequency) characterizing time and frequency components of humpback song signals were measured. Song patterns were examined by counting song units and phrase types. Boat noise was measured in the bandwidth according to the accompanying song phrase (1 kHz or 4 kHz) by calculating RMS values of non-song segments (inter-unit spaces) for each phrase. Experimentally introduced noise from the small vessel was approximately 15 dB higher than ambient noise while noise from large vessels was approximately 15-20 dB higher than ambient noise. Noise from both small and large vessels was broad-band with most energy distributed below 4 kHz. Correlation analysis are being used to compare song variables to noise. These results are being used to categorize boat noise (high RMS values) and ambient noise (low RMS values) to statistically test for differences in song variables values. Results will have important implications relating to management of humpback whale populations and habitat (e.g. Hawaiian Island Humpback Whale Sanctuary) and may provide insights into the effects of man-made low frequency signals (ie. ATOC) on the acoustic behavior of cetaceans.

COMPARATIVE INTERIOR MORPHOLOGY OF FORELIMB BONES OF MARINE MAMMALS

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Little is known about the interior morphology of the forelimb bones of marine mammals. Previous investigators observed that flipper bones of cetaceans lack discreet medullary cavities and have cancellous texture with reduced or absent compact cortices. This morphology was unaffected by age or sex. Our study has found distinct differences in cetacean flipper bone morphology ranging from highly compact bone as seen in terrestrial mammals to highly porous bone as seen in the common dolphin *(Delphinus delphis)*.

We have examined the radius and ulna of 11 cetaceans and 3 pinnipeds (loaned by the California Academy of Sciences) by x-ray computed tomography (CT, GE 9800) to determine their interior structure. An additional six samples were collected from necropsies for histological examination of mid-shaft sections. Tissue area (T) and porous area (P) were determined and percent compact tissue calculated by the equation: (T-P)/Tx100. Variation of multiple measurements was less than 2.0%. Among cetaceans, the percent of compact bone ranged from 0% in *Phocoena phocoena* humerus and *Mesoplodon sp.* humerus and ulna to 65% in Orcinus *orca* radius. In pinnipeds, *Zalophus californianus* and *Phoca vitulina* were 58% and 41% respectively. By comparison, bovine bone has 47% compact bone. This suggests that marine mammals have a varying degree of compactness in their foreflipper bones and that some cetaceans have as much compact bone as terrestrial mammals. Further studies could relate the degree of skeletal compactness to age, sex, diving habits, blubber mass, phylogenetic relationships or time spent on land (Pinnipeds). Supported by NIGMS-MBRS RR 01882.

SPRING AND SUMMER PREY OF THE JUAN FERNANDEZ FUR SEAL

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Juan Fernández fur seal (*Arctocephalus philippii*) prey composition was assessed through analysis of 515 scats, collected during five reproductive seasons (1987-1991). A total of 14 collections was analyzed and, based on 4172 fish otoliths and cephalopod beaks, only 13 prey taxa were identified.

The occurrences of fish families were: Myctophidae (80.3%) Scomberesocidae (10.0%), Carangidae (9.5%), Engraulidae (1.0%), and Bathylagidae (0.7%). Cephalopod orders included both Teuthoidea (41.8%) and Octopoda (0.7%). In a single comparison between female scats and subadult male/juvenile scats, cephalopods were more frequently found in the former ($p<0.005$), whereas the myctophid *Symbolophorus sp. B* was more frequently found in the latter ($p<0.025$). The occurrence of squid (*Onychoteuthis banksii*) in subadult male/juvenile scats differed significantly between years ($p<0.001$). Within year variations were significant only for the occurrence of cephalopods in 1989.

Historic data from oceanographic sampling suggest that the narrow range of species, upon which Juan Fernández fur seals prey, is unlikely to represent specialization but, rather, is probably due to overall prey availability in the pelagic environment. Although information on marine communities in this area is limited, it is possible to relate observed prey shifts to ocean surface temperature variation.

APPARENT VS. TRUE PREGANCY RATES OF ANTARCTIC FIN WHALES FOR THE 1930/31-1975/76 WHALING SEASONS

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A novel baleen whale breeding cycle dynamics population model was modified to incorporate actual BIWS catch statistics for Antarctic pelagic fin whales. Each animal killed was placed in an appropriate age/sex/reproductive status cohort, thus allowing exact duplication of all apparent pregnancy rates (APRs) and harvest sex ratio data.

True pregnancy rates (TPRs) were simulated with a variety of density-dependent assumptions: (1) mean breeding cycle length varied from a maximum of 4.0-, 3.5-, or 3.0-years to a minimum of 4.0-, 3.5-, 3.0-, 2.5, 2.0-, or 1.5-years; (2) mean age at sexual maturity declined from 12-years to a minimum of 12-, 9-, or 6-years; and (3) mean age at recruitment decreased to a minimum of three years less than a maximum value of 12-, 10-, or 8- years. Initial population sizes (N_0) were adjusted to allow a total population size of 66,100 whales for the 1970/71 whaling season (Chapman & Breiwick 1979).

These parameter combinations produced a total of 135 simulation runs, 84 of which were "successful" in that they met all of the criteria of the BIWS catch statistics for the 1930/31-1975/76 whaling seasons. Even though APRs were identical for all simulations, each set of TPRs associated with these same APR data were different. Thus, any one of the 84 simulated TPR data sets (as well as many others) may represent a reasonable scenario for Antarctic fin pregnancy rates from 1930-75. It is impossible to ascertain which set of parameter combinations would produce the most likely TPR data set; therefore, APR data cannot be reliably used to estimate or calculate TPR data.

All (27) 1.5-year and most (20) 2.0-year minimum cycle length simulations failed, and minimum cycles reached only 2.2-years. Thus, it is unlikely that these populations ever achieved mean cycle lengths as low as 1.8-years. Analysis of 34 "breakpoint" runs indicated that catch failures were clustered among the 1960/61 to 1964/65 whaling seasons.

INTRASPECIFIC STRUCTURE OF THE BELUGA WHALE *(DELPHINAPTERUS LEUCAS)*: FROM POPULATION IDENTITY TO SOCIAL ORGANISATION USING A NUMBER OF MOLECULAR TECHNIQUES.

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Three molecular techniques offering different orders of resolution are being used in a comprehensive genetic investigation of the intraspecific structure of the beluga whale in Alaskan and NW Canadian waters. The three methods under study are: (1) the direct sequencing of a region of the mtDNA genome, (2) the rapid detection of DNA polymorphisms using arbitrarily primed PCR (termed *RAPD PCR*) and (3) the development of a novel approach for genotyping highly polymorphic microsatellite DNAs.

To date (July), total cellular DNA has been extracted from 50 individuals collected from a number of locations in Alaska and NW Canada. Initial results from sequencing the control region of mtDNA have not, as yet, revealed geographically concordant structuring. Optimal reaction conditions have been determined for several RAPD primers. A number of polymorphisms have been detected among individuals both within and between 'populations'. Preliminary analysis detect frequency differences in some polymorphic DNAs between areas. The microsatellite technique under development essentially involves the use of the PCR with hybridization-probe technology to identify polymorphic loci, coupled with fluoresent tagging and high resolution PAGE to distinguish variant alleles, which often differ by as little as a few base pairs. Fluorescent labelling of PCR products used in conjunction with GENESCAN™ software enables automatic and unambiguous screening of several independent loci simultaneously. The approach has several advantages over existing, more labour-intensive techniques. Microsatellite containing sequences have been successfully identified and amplified. We are at present labelling the repeat DNAs and screening for polymorphisms.

ENERGETICS OF LACTATION IN THE HARP SEAL

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Harp seals (*Phoca groenlandica*) give birth on pack ice and nurse their pups for about 13 d. Previous estimates of the reproductive energetics of this species have been based largely on morphometric data. We undertook a longitudinal study at the Front off northeastern Newfoundland, Canada in which 5 pups were given deuterium oxide at 0-5 days of age, and recaptured 3-4 times over a 6-8 day period. In addition, data were obtained on body water content by isotope dilution (n=17) and on body composition by chemical analysis (n=12). The proximate composition of harp seal milk (n=21) was also assayed. Harp seal pups contained little fat (3%) at birth, but the rapid increase in body mass (about 2.3 kg/d) was accompanied by substantial fat deposition, with the result that fat accounted for 47% of body mass at weaning. Body water estimated by isotope dilution was not significantly different (mean difference 1.7%) from water content measured directly (n=9 paired samples); water comprised 72% of lean body mass. From birth to weaning, milk lipid increased from 36% to 57%, and milk water declined from 51% to 32%. The change in milk composition explains in part the observed decline in water turnover rate (from 13-16% to 8-9% of body water per d), since the rate of milk intake remained relatively constant (3.7 kg/d). On average, pups consumed about 18 Mcal/d. This daily rate of energy intake is similar to previous indirect estimates.

HIGH RESOLUTION DIVING RECORDS OF ELEPHANT SEALS YIELD DIFFERENT PERSPECTIVES.

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Our objective was to provide fine scale descriptions of the temporal patterning of diving and surfacing in northern elephant seals, Mirounga angustirostris, and to compare these descriptions with previous findings utilizing slower sampling protocols. Time-depth recorders programmed to sample at 1 and 5 second intervals were attached to 25 juvenile elephant seals of both sexes in the spring or fall of 1990 to 1992 and translocated up to 70 km from Año Nuevo Island, California. The TDRs, recovered when the seals returned "home" in 1-9 days, revealed that: 1) precise time at the surface ($\bar{X}$= 1.04 ± 1.03 min.) is less than expected; 2) ascending seals slow down and level out before surfacing; 3) reversals are seen descending and ascending between 10 and 60 meters in 45% of dives longer than 1 minute; 4) brief, shallow dives are more frequent than previously observed; 5) dive shapes exhibit greater resolution than seen in previous studies. Video recordings of diving in translocated seals confirmed the first two points. High resolution diving records yield a different perspective on elephant seal diving which elucidate our understanding of behavior, physiology and limits to technical applications, such as tracking with GPS.

PRESENCE OF A SUPERNUMERARY DIGIT IN THE FLIPPER OF VAQUITA, PHOCOENA SINUS.

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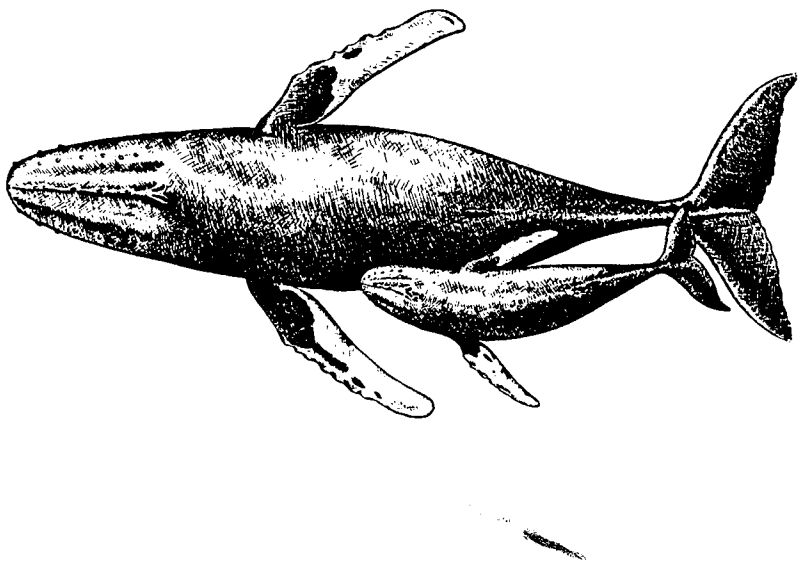
The skeletal structure of the pectoral flipper of the vaquita (Phocoena sinus) was determined by examining specimens from 15 individuals. Specimens were examined using alizarin red S staining, radiography, dissection and preparation of skeletal samples using dermestid beetles to clean the bones.

The presence of a previously undescribed phalangeal series was discovered. In it, a line of cartilage arises from a postaxial process in the third metacarpal bone. The cartilage is oriented distally and ossifications (phalanges) are present. The number of ossifications present varies among individuals and between the left and the right flipper of the same individual. In some cases tendon tissue is associated with the phalanges. The presence of this structure appears to be unique to P. sinus and shows a tendency toward the production of a sixth digit, located between the third and fourth digits.



WATER BALANCE IN CAPTIVE MANATEES (*Trichechus manatus*)

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West Indian manatees (*T. manatus*) are unique amongst marine mammals in that they are capable of inhabiting both fresh and salt water environments. The focus of this study was to determine if either of these habitats affected the animal's ability to balance water flux. Three animals in fresh water were studied, with two animals exhibiting different feeding patterns from the third. Mean water turnover rate for the two similar animals was 0.113 ± 0.026 $L \cdot kg^{-1}d^{-1}$ or 20.6 ± 1.6 L/d with a mean D_2O half-life ($T_{1/2}$) of 3.2 ± 0.6 d. The other manatee had a turnover rate of 0.048 $L \cdot kg^{-1}d^{-1}$ or 6.6 L/d with a $T_{1/2}$ of 7.75 d. In October, 1992, these three animals had an average lean body mass (LBM) and fat content of 75.2 ± 3.4 % and 24.8 ± 3.4 %, respectively. In January, 1993, the animals had mean LBM of 65.6 ± 1.8 % and fat content of 34.4 ± 1.8 %. Only one animal was examined in salt water, but was serially sampled over a year. His average water turnover rate was 0.040 ± 0.010 $L \cdot kg^{-1}d^{-1}$, ranging from 4.3 - 17.2 L/d, with a mean $T_{1/2}$ of 8.6 ± 2.5 d. Data suggest that manatees in salt water do not drink actively and attain their required water from their food and metabolism.

ISOLATION OF A RHABDOVIRUS FROM A WHITE-BEAKED DOLPHIN (Lagenorhynchus albirostris)

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From the lungs and kidney of a white-beaked dolphin that had beached in a poor condition on an island in the Dutch Waddensea and had died two days later with signs of a severe pneumonia, a virus was isolated in Vero cells. By negative contrast electron microscopy the virus was shown to have rhabdovirus morphology, and was therefore tentatively named dolphin rhabdovirus (DRV). DRV replicated in cells from several mammalian species, could infect rabbits and mice, and caused a lethal infection upon intracerebral infection of suckling mice. DRV proved to be antigenetically distinct from rabies virus, vesicular stomatitis viruses and bovine ephemeral fever virus. DRV neutralizing serum antibodies were found in several cetacean and pinniped species living in the European waters.

VISIBILITY BIAS DURING AERIAL SURVEYS OF HARBOR PORPOISE *PHOCOENA PHOCOENA* IN OREGON AND WASHINGTON

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Aerial line-transect theory assumes that visibility decreases as a function of distance from the track-line but is perfect near the track-line (g(0)=1). If factors such as animal submergence, sea state, cloud cover, and glare reduce visibility near the line (g(0)<1), a downward bias in the estimated abundance results. We conducted a calibration experiment to estimate the probability [g(0)] that all porpoise groups are detected near the aerial transect-line. Shore-based observers visually tracked porpoise groups using theodolites and recorded locations, group sizes, and surfacing rates (real time) while an aircraft flew transects through the study area. Four criteria were considered for selecting the air/shore sightings which were best for analysis purposes: 1) time of sightings (real-time), 2) relative sighting location (within 300 m), 3) maximum distance from the aerial track-line (100 m), and 4) group size agreement. These selected data were used to determine whether a group at or near the surface was seen by the aerial observers. A correction factor [1/g(0)] of 3.1 was derived from these data to adjust past aerial harbor porpoise sighting data for groups missed. This correction factor agrees closely with that of Barlow et al. (1988: U.S. Fisheries Bulletin 86 (3):433-444) and has a sufficiently low variance estimate (SE=0.048) for use in abundance estimation.

SEASONAL ABUNDANCE, MOVEMENTS, AND FOOD HABITS OF HARBOR SEALS IN ELKHORN SLOUGH, CA

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This study examined abundance patterns, movement patterns and food habits of harbor seals (Phoca vitulina) in Elkhorn slough to provide information on habitat utilization and their interaction with the estuarine fish community.

Harbor seals were counted a minimum of twice per month at haul-out sites in Elkhorn Slough during 1991. Although there was no significant difference in seasonal abundance, number of seals had increased 3 fold since 1984, from 35 to greater than 110.

Eight juvenile harbor seals (5 females and 3 males) were radio-tagged and tracked from Sept. 1991 to April 1992. All tagged seals were successfully relocated each month. During bi-weekly day/night surveys of the Monterey Bay area, tagged seals were found in Elkhorn slough during the day an average of 94% of the time, where they were observed ashore or resting in the water. Seals were usually swimming and diving in Monterey Bay at night (90%). Individuals located in the bay at night were always found in the slough on subsequent days. This activity pattern remained unchanged throughout the study period. Seals hauled out during the day, regardless of tide height. Dives conducted in Monterey Bay ($\bar{x}$ = 4.32min, S.D. = 2.35min) were significantly longer than those performed in the slough ($\bar{x}$ = 1.80min, S.D. = 1.50min).

Harbor seal scats were collected each month during 1991 from haul-out sites in Elkhorn Slough. Octopus (Octopus sp.), squid (Loligo opalescens), and spotted cusk eel (Chilara taylori) were the most common and numerically important prey species eaten throughout the year. Rockfish (Sebastes sp.), English sole (Pleuronectes vetulus), and Dover sole (Microstomus pacificus) were important during summer months (May, June, July). There was no similarity (PSI's < 0.18) in species composition between seal diet and otter trawls conducted in Elkhorn Slough, indicating seals feed mostly in the bay.

DOLPHIN SWIMMING MECHANICS: BIAXIAL PROPERTIES OF THE SUBDERMAL CONNECTIVE TISSUE SHEATH

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Dolphins can be modeled mechanically as fiber wound, thin-walled pressurized cylinders: they are cylindrical in shape, and their axial muscles are wrapped circumferentially by a collagenous fiber-reinforced membrane, the subdermal connective tissue sheath (SDS). Constructional features of the SDS, such as fiber angle, fiber size, sheath thickness, and connections between the SDS and the locomotor muscles and skeleton vary along its length, suggesting the SDS has regionally specific mechanical behaviors. We performed biaxial tensile tests on the SDS from the thorax and the caudal tailstock. The mechanical behavior of the tailstock SDS is strongly asymmetric: the sheath becomes stiff at smaller strains, and develops more stress in the circumferential than in the longitudinal direction. Contrarily, the thoracic SDS displays similar mechanical properties in the circumferential and longitudinal directions. The tailstock SDS is stiffer in both directions than the thoracic SDS. These mechanical results support the hypothesis that the functions of the sheath vary regionally. The mechanical properties of the thoracic SDS suggest that it may act as an external tendon, transmitting muscular forces along the periphery of the dolphin. The circumferential stiffness of the SDS surrounding the tailstock suggests that the posterior SDS functions as a retinaculum for the terminal tendons of the axial, locomotor muscles.

THE PRESENCE OF SHIP AVOIDANCE DURING A LINE TRANSECT SURVEY OF HARBOR PORPOISES IN THE GULF OF MAINE

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When using the line transect methodology to estimate abundance of marine mammals, many assumptions are made. One assumption is that the animals do not change their behavior due to the presence of the sighting platform before they are detected by a sighting team. The presence or absence of behavioral changes of harbor porpoises in front of a survey ship was investigated during a sighting survey in the Gulf of Maine in August 1993 by comparing the distribution of sightings as seen by two teams of people. One team (3 people), following standard line transect procedures, searched the waters close to the ship using the unaided eye and the other team (1 person) searched the waters close and far from the ship using 25x150 binoculars. Both teams recorded the position and swim direction of harbor porpoise groups. It was determined that the distribution of swim directions of animals far in front of the ship was different than that of animals that were close to the ship. These distributions were compared to several hypotheses of what the true distribution should be if there was no behavior modifications. The data indicate that some harbor porpoises avoid the ship before they are detected by the unaided eye. The effect of this amount of avoidance on the abundance estimate is also discussed.

EVOLUTION OF HIGH LATITUDE FEEDING AGGREGATIONS OF HUMPBACK WHALES, *MEGAPTERA NOVAEANGLIAE*, IN THE NORTH ATLANTIC.

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We sequenced 288 basepairs of the mitochondrial D-loop in 130 biopsy samples from humpback whales, *Megaptera novaeangliae*, representing five North Atlantic and one Antarctic high latitude feeding grounds. 33 different sequences were identified. Significant differences were found between the Antarctic and all North Atlantic areas, as well as between Iceland and the western North Atlantic samples. A genealogical tree was estimated by maximum likelihood from the 33 haplotypes and rooted with fin whale D-loop sequences. The branching pattern in the genealogical tree suggested that the North Atlantic Ocean has been populated by two independent migrations of humpback whales; one from a common ancestral population followed by another later migration, probably from the Antarctic. The lineages representing the first migration were found in all North Atlantic areas, whereas lineages belonging to the second migration were found only in the western North Atlantic.

VARIATIONS IN TERRITORY TENURE IN THE MALE SOUTH AMERICAN FUR SEAL

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Male South American fur seals defend territories at traditional sites. Territorial behaviour can vary in length, timing and number of territory tenures. This study aimed to examine the relationship between these variations in territorial behaviour and male copulatory success.

The study took place at Punta San Juan, Peru. 176 males were identified during the 1992 breeding season. Of these, 76 were observed each day of their tenure and all copulations were recorded.

71.1% of males held single tenures, 23.7% returned once and 5.3% returned for an additional tenure. The mean number of days that males were present was 14.6 for single tenures and 28.5 for multiple tenures. Median starting dates for the first of multiple tenures was significantly earlier than those for single tenures. The mean number of copulations of multiple tenured males was three times that of males who held single tenures.

These data indicate that by returning for a second tenure males can gain additional copulations. This behaviour has not been reported in other studies of male otariids and may be related to the extended breeding season of this tropical breeding species.

Immunocontraception of Seals.

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The harp and grey seal populations in the Western North Atlantic have increased significantly during the last decade suggesting a need to control further population increases. To be useful in immunocontraception of seals, a vaccine must be effective following single injection, last for 5-10 years with full return of fertility, and be remotely delivered. We have developed a vaccine which satisfies the requirements of being remotely delivered and producing high anti-ZP antibody titers which persist for at least two and one-half years after a single administration. The requirements of fertility return and duration of anti-ZP titers are presently being evaluated. The vaccine is based on the use of zona pellucida glycoproteins, cloned exons from seals, and a lipsome-based delivery system. Field trials using grey seals indicate that immunocontraception was achieved in 15-20% of females in the first year. This was probably due to the effects on implantation rather than sperm binding as titers were low during the breeding period (2-3 weeks after vaccination) whereas titers were high 3-4 months after vaccination when implantation would have occurred. Measurement of anti-ZP titers one year after vaccination suggests an overall effectiveness of 85% which will be confirmed in 1994.

A PRELIMINARY ANALYSIS OF SERUM AND TISSUE SAMPLES FROM A *TURSIOPS TRUNCATUS* (BOTTLENOSE DOLPHIN) MOTHER, CALF, AND PLACENTA

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Following the birth of a calf to a 23+ year old *Tursiops truncatus* at Marine Life Oceanarium in Gulfport MS, blood samples were taken from the mother and from the intact placenta (which was retrieved immediately after it was expelled by the mother). A routine blood sample taken from the mother two days prior to parturition was also available. The apparently healthy calf died unexpectedly at five weeks of age of multifocal, necrotic hepatitis and subpleural pneumonia (possibly complications of a septicemic process). A blood sample was obtained within six hours post mortem. Blood chemistries and complete blood counts were performed on all blood samples. Values were normal for samples from the mother. Although some values were outside of normal ranges in the placental and calf samples, the lack of previous data on such samples precluded any conclusions. Primary tissue culture was attempted using trypsin-digested kidney and lung tissue taken from the calf 10-12 hours post mortem. A few small colonies of fibroblastic cells developed in the kidney cultures within eight days, surviving for approximately two weeks before deteriorating. Several immunoelectrophoretic procedures (Graber-Williams, crossed, tandem-crossed, and rocket) were used to analyze and compare serum obtained from the placenta, calf, and mother. Immunoglobulin peaks were evident in the maternal and calf samples, but not in the placental sample. The number and concentrations of all serum proteins were highest in the maternal samples and lowest in the placental sample.

A POTENTIAL ROLE FOR PARATHYROID HORMONE IN MOBILIZATION OF SKELETAL MINERAL OF LACTATING NORTHERN ELEPHANT SEALS.

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Parathyroid hormone is a primary stimulator of skeletal calcium mobilization in mammals, yet its role in lactation is poorly understood, in part due to uncertainties of intestinal and renal calcium absorption. Lactating northern elephant seals *(Mirounga angustirostris)* provide an interesting experimental subject in which to study mineral mobilization, because ingestion and excretion need not be considered, and because their bone is almost entirely trabecular. During their 1 month nursing periods, females completely abstain from nutritional intake, while transferring as much as 10% of their skeletal mass to their pups, along with other nutrients. To gain a better understanding of this process, we obtained serum (n = 12) and milk samples (n = 9) from females at 3 and 24 days of lactation. We measured intact parathyroid hormone (PTH, Nichols Institute), alkaline phosphatase (AlP), calcium (Ca) and phosphorus (Pi) in serum, and Ca and Pi in milk. In addition, bone samples from three females (two lactating, one molting) which died on the rookery of apparent trauma were examined histomorphometrically.

PTH decreased by 46% from 3 to 24 days lactation ($p < 0.005$), when it was comparable to non-lactating females. AlP also decreased significantly, Ca was unchanged, and Pi increased. Milk Ca and Pi both decreased and were significantly correlated. Bone sections indicated greater resorbtion than formation in the mid-ulnae of two lactating females, while a molting female exhibited a predominance of formation. This documents extensive bone resorption and suggests that PTH is important in initiating mobilization of both Ca and Pi during lactation.

USE OF DEUTERIUM OXIDE DILUTION, BIOELECTRIC IMPEDANCE, AND ZOOMETRY TO MEASURE BODY COMPOSITION OF CAPTIVE HAWAIIAN MONK SEALS

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The body composition of six captive Hawaiian monk seals (Monachus schauinslandi) was measured using deuterium oxide (D_2O) dilution, bioelectric impedance analysis (BEI), and zoometry. The D_2O technique has been used extensively to estimate total body water in mammals and is useful for validating the results of BEI. BEI is a noninvasive, portable method of estimating body composition that would be useful for taking measurments of seals in the field. The correlation coefficients between D_2O and BEI, total body weight, total body length, axillary girth and pelvic girth were 0.758, 0.979, 0.697, 0.983, and 0.914, respectively. The lean mass of 4 adult male monk seals (>10 yrs old) was 147.2 ± 4.7 kg and fat mass was 78.4 ± 2.6 kg. The lean mass of 2 female seals (6-7 yrs old) was 87.1 ± 9.0 and fat mass was 30.5 ± 2.2 kg. A combination of these techniques are being used to assess the body composition of juvenile seals collected for rehabilitation.

THE USE OF MARINE MAMMAL PARTS IN ABORIGINAL MEDICINES BY THE ZULU NATION OF SOUTH AFRICA.

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Investigation of the uses of marine mammals in Zulu aboriginal medicines by Sangomas and Inyangas (medicine-men) indicated widespread belief in the medicinal properties of particularly blubber fat, bone and heart. Nearly all medicinal applications required the addition of "herbs" which could include crushed tree bark, orchid leaves, dried seeds or roots. It is probable that these plant additives contain the major portion of the medicinal properties and that the marine mammal parts act as the binding medium.

Marine mammal oils are included in topical ointments, laxatives, emetics, and for lightning protection. Bone is primarily used in mixtures designed to increase agricultural production whilst dolphin heart is included in a "love potion". Many of the uses were duplicated in separate geographical regions implying that they have been used in Zulu medicines for some time. The low stranding rate on the Natal/Kwa-Zulu coast and the importance of sperm whale oil suggests that the use of marine mammals may have gained popularity during the whaling era (pre-1976).

HARBOR PORPOISE MANAGEMENT IN THE GULF OF MAINE UNDER THE ENDANGERED SPECIES ACT

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On January 7, 1993, the National Marine Fisheries Service (NMFS) proposed that the Gulf of Maine (GME) population of harbor porpoise, Phocoena phocoena, be listed as threatened under the Endangered Species Act (ESA) due, primarily, to the level of incidental bycatch of harbor porpoise in the GME bottom-gillnet fishery. At the time of the proposed listing, the estimated number of harbor porpoise taken in GME gillnet fisheries exceeded twice that considered sustainable by NMFS given the estimated size of the GME harbor porpoise population. Furthermore, regulations to reduce or to limit the level of incidental bycatch by this fishery did not exist at the time of the proposed listing.

Since the proposed listing, NMFS has been working with the New England Fishery Management Council (NEFMC) to develop, as part of a GME multispecies fishery management plan, a bycatch reduction program that would progressively reduce the total harbor porpoise bycatch in gillnet fisheries by greater than 50 percent. Restrictive fishing measures being considered to reduce bycatch include area closures, seasonal restrictions, incidental take allocations and other effort reduction measures. Modifications to gillnet fishing gear or practice include the use of acoustic deterrents during gear deployment, and the placement of deterrents or "pingers" on the net while it is fishing.

NMFS has until January, 1994, to make a final determination on whether to list the GME harbor porpoise as threatened under the ESA.

PREY OCCURRENCE IN SPOTTED DOLPHINS FROM THE EASTERN TROPICAL PACIFIC

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Prey items were examined from 428 eastern tropical Pacific spotted dolphin (Stenella attenuata) stomachs. Fifty-three species of fish and 38 species of cephalopods were identified using fish otoliths and cephalopod beaks. The most frequently occurring species of fish were from the Family Myctophidae which occurred in 49% of the stomachs and represented 75% of the fish by number. The most frequently occurring species of cephalopods were from the Family Ommastrephidae (squids) which occurred in 65% of the stomachs and represented 28% of the cephalopods by number. These species of fish and cephalopods are associated with the deep scattering layer. These results differ from the prey in yellowfin tuna stomachs in which 42% of the cephalopod composition consisted of octopus from the Family Argonautidae, a species found in near surface waters (unpubl. data, IATTC). The dolphin sample was stratified by geographic area and oceanographic season, and a significant difference was found to occur in the number, occurrence and proportions of both fish and cephalopods across all areas and by season. A significant difference was also found in the time of day the dolphins were feeding. More full stomachs were found in the morning hours while no full stomachs were found later in the afternoon, suggesting that the dolphins are feeding at night when prey from the deep scattering layer migrates upward.

THE USE OF AQUATIC DISPLAYS BY ADULT MALE HARBOUR SEALS DURING THE BREEDING SEASON

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Possible self-advertising and territorial maintenance functions of aquatic displays of male harbour seals (*Phoca vitulina*) were investigated at Miquelon. The aquatic display behaviour, haul-out patterns, and aggressive interactions of nine adult males were video-taped over two consecutive breeding seasons. Data were also collected on the haul-out patterns of other seals.

Displays started during parturition and continued until the last pups were weaned. Three pieces of evidence suggest that displays are involved in territory maintenance and defence: 1) simultaneous displays occurred regularly between neighboring males in specific locations, 2) displays following fights and chases also occurred at these same locations, and 3) displays only occurred within the area described by these haul out locations when an intruder was found there. Displays occurred during the three hours before high tide and four hours following high tide but none occurred from 5 to 8 hours after high tide. The rate of displaying was highest during the two hours immediately following high tide when animals were gathering at haul-out locations within territories.

The rate of displaying increased with the number of boundaries a male defended, although, when corrected for number of boundaries, there was no difference in the rate of displaying between males. These results suggest that one function of the display is territory maintenance and defence, but do not exclude the possible role of the display in self-advertising.

DIEL PATTERNS OF "STRAND FEEDING" BEHAVIOR BY BOTTLENOSE DOLPHINS IN SOUTH CAROLINA SALT MARSHES

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Bottlenose dolphins (*Tursiops truncatus*) in the *Spartina* marsh system near Hilton Head, South Carolina employ a unique foraging strategy. Groups of two or more will, in a synchronized effort, force a school of fish onto mud banks, beaching themselves in the process. While on the banks the dolphins then pick up and eat the stranded prey. Observations during all seasons over a four-year period reveal that "strand feeding" in the study area is limited to animals which are long-term or permanent residents, and that foraging pods are composed of relatively stable subgroups within this population.

The use of light-enhancing night vision equipment revealed that the foraging behavior occurs during the day and at night. The strand feeding behavior and movements within the study area are determined by tidal stage and are independent of light levels of the day-night cycle. Occurrences of the "strand feeding" foraging technique are generally limited to within two hours of the low tide when the beaches are exposed. Use of the technique of strand feeding is independent of water temperature but only occurs when the Secchi depth is less than 50 cm.

Beaching sites are determined by prey location, and strand feeding does not involve herding. Detailed sonar profiles of bottom topography at consistently used stranding sites revealed the existence of "structures" at all sites which result in concentrations of their primary prey fish (striped mullet, *Mugil cephalus*).

CETACEANS STRANDINGS AT NORTHEASTERN BRAZIL (1989-1993)

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Little is known about cetaceans occurence at Northeastern coast-Brazil. From 1989 an effort was conducted with fishermen and villagers to gather all information about strandings of marine mammals to be attached to the list of already existing data of FAUNE-Groupo de Mamíferos Aquáticos-NE. Along 2,000 km of coast surveyed we identified eleven strandings while some others mentioned by residents. Without concise data were not compiled in this work. Four species of odontocetes (Physeter macrocephalus, Globicephala spp., Stenella longirostris, and Ziphius cavirostris) and two mysticetes (Balaenopteridae) were recorded. P. macrocephalus is the most common cetacean to strand in Northeastern waters, making up 66.7% (N=9) of all odontocetes. These strandings were more likely to occur during October and November. The analysis of stranding records, including date, total length, sex and species, were obtained for all individuals. The large number of undetermined mortality causes for all species, clearly indicates that the majority of the cases were not thoroughly documented or necropsied to determine cause of death. A practical approach to unraveling the stranding problem in the Northeastern coast requires a continous and extensive program to include and integrated plan to get biological data and process stranded animals.

DATA ON THE MORPHOLOGY AND LIFE HISTORY OF CENTRAL AMERICAN SPINNER DOLPHINS TAKEN FROM VERTICAL AERIAL PHOTOGRAPHS

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Lengths measured from aerial photographs were used to examine the morphology and reproductive season for the central American spinner dolphin (Stenella longirostris centroamericana). Few data are available for this species, primarily because they are not significantly impacted by fisheries. This spinner dolphin ranges along the continental shelf from south of the Gulf of Tehuantepec to Panama. Using a stereo comparator, we measured the lengths of 1600 central American spinner dolphins from 4 schools that were photographed in August 1992 off the coast of Guatemala. For females, sex was inferred by the close association of a calf. Asymptotic length for males and females was estimated to be 229 cm and 218 cm, respectively. The average adult length for females was 198 cm (range 172 - 219 cm). Calves aged less than 1 year comprised 8.2 % of the sample. The back-projected birth dates, indicate a single spring reproductive pulse.

REGIONAL VARIATION IN DIETS OF COMMON SEALS *Phoca vitulina* AND GREY SEALS *Halichoerus grypus* IN SCOTLAND

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Seal faeces were collected from coastal haul-out and breeding sites around Scotland during 1993. The main sampling sites were the Summer Isles (west coast), Orkney (north coast), the Moray Firth, Bullars of Buchan, and the Isle of May (east coast). Seal stomachs were also collected from seals killed by salmon fishermen. Fish otoliths and cephalopod beaks were identified and measured to estimate prey size.

The main groups of fish eaten were Gadidae (cod *Gadus morhua*, whiting *Merlangius merlangus*, haddock *Melanogrammus aeglifinus*, ling *Molva, molva*,), Ammodytidae (sandeels *Ammodytes* spp.) and Pleuronectidae (dab *Limanda limanda*, long rough dab *Hippoglossoides platessoides*, plaice *Pleuronectes platessa*, lemon sole *Microstomus kitt*). A range of other fish were also identified including dragonet *Callionymus lyra*, lumpsucker *Cyclopterus lumpus* and herring *Clupea harengus* The only cephalopod identified was the octopus *Eledone cirrhosa*.

Results provide evidence of significant regional variation in diet. For example, grey seal samples from the spring consisted mainly of sandeels and whiting at Bullars of Buchan, while whiting and dragonets were important at the Isle of May and samples from mixed haul-outs in Orkney contained mostly sandeels. Results are compared with those of similar studies completed during 1986-1989.

STRANDINGS OF THE HUMPBACK WHALE IN THE MID-ATLANTIC AND SOUTHEAST REGIONS OF THE UNITED STATES, 1985 - 1992.

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Stranding data for humpback whales (Megaptera novaeangliae) along the eastern seaboard of the United States (New Jersey - southeastern Florida) were examined for the years 1985 - 1992. Significantly more animals stranded during the last half of the study period (1989-1992) than the first (1985-1988) ($P \leq 0.025$, $n=34$). North Carolina had the greatest number of strandings (n=13). However, the density of strandings, measured as strandings per kilometer of coastline, was greatest in Virginia (.055). A significantly elevated area of strandings extended from Chesapeake Bay, VA to Cape Hatteras, NC ($P<0.01$).

Body length data demonstrate that all stranded animals were sexually immature, with many being newly independent calves. Significantly more animals stranded during the months from October - March ($P=0.04$), when humpbacks are traveling to/from or congregating in the West Indies. This may represent a previously undocumented seasonal segregation by age/reproductive class. Sixty percent of adequately documented animals show evidence of ship strike and/or entanglement in commercial fishing gear, suggesting that anthropogenic factors may have a negative impact on animals inhabiting the study area.

EXPOSURE OF GREY SEAL PUPS TO CHLOROBIPHENYLS DURING LACTATION.

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Lactating grey seals mobilise blubber stores to produce lipid-rich milk for their pups. Highly lipophyllic contaminants are delivered along with milk, at a time when the pup's immune function is immature. We investigated postpartum exposure of pups to chlorobiphenyls (CBs) by measuring concentrations of 27 CB congeners in milk samples collected from individually identified female breeding grey seals (n=13) in 3 consecutive breeding seasons at the Isle of May, Scotland. Milk samples were collected from each female on up to 3 occasions during each breeding season, typically on days 3, 9 and 16 of lactation.

Total milk intake of pups, estimated by isotope dilution, was in the range 36.0 - 76.9 kg. Total CB (expressed as the sum of 27 congeners) in milk lipid delivered in a season ranged from 0.21 - 1.08 g per female, differing by up to 38% for pups born to the same female 2 years apart. Congener profiles were similar in all milk samples but individual CB levels (expressed as ng/g milk lipid) differed by a factor of two during a single season and between years in some study females.

A SIGHTING/STRANDING NETWORK IN FRENCH POLYNESIA

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In 1988 I established French Polynesia's first cetacean sighting/stranding network. To date I have received 390 reports on 16 different species near 28 different islands. Reports have included photos, videos, and/or acoustic recordings, thus permittiing species confirmation, group size determination, and identification of individuals. Shipboard GPS systems have provided precise locational data. My own systematic field surveys at six islands corroborate most findings.

Of particular interest: Stenella longirostris were observed (n=172 sightings) in all months, at 16 islands, in or near barrier reef passes, or in bays. Megaptera novaeangliae were observed (n=125 s) July-Oct., at 18 islands; the presence of surface active groups, recently born calves, and singers all suggest that F.P. is a previously undisclosed calving/breeding ground. Steno bredanensis were observed (n=32 s) year round, at 6 islands, were most often associated with fish and/or bird aggregations, and were implicated in human fishery interactions. Mesoplodon densirostris were observed 7 times March-Aug. at Moorea, although there are only two published records from the entire south Pacific between Australia and Chile

Five strandings at three islands included 3 Ziphius cavirostris, 1 Mesoplodon densirostris, 1 Steno bredanensis, and 1 neonate Stenella longirostris. I performed necropsies on all but the Ziphius, and obtained selected histological samples, stomach contents, skeletons, and teeth.

ADVANCED SIGNAL PROCESSING FOR MARINE MAMMAL CARDIOLOGY

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An innovative study of the application of advanced signal processing techniques to marine mammal ECG data is presented. The objective of the study was to compare the cardiac diagnostic information available from the standard ECG displays (time vs. amplitude) with displays representing time-frequency signal processing of the same ECG data. Time frequency processing is a relatively new form of advanced signal processing that is optimized on short duration signals that vary over time, e.g., the heartbeat. There are several different algorithmic kernals that have been developed for time-frequency signal processing. Our method was to develop a dual screen workstation environment that supported comparison of the standard ECG output with the display output of a variety of time-frequency kernals on the same ECG marine mammal data. Our results clearly demonstrate that certain time-frequency kernals applied to ECG data permit the electrophysiologist to see essential frequency details of the QRS and post QRS complex. These details allow, for the first time, a clear depiction of the heart's polarization cycle, localization of myocardial infarct damage and diagnosis of a late potential (possible sudden death) within a single heartbeat.

HEART RATE RESPONSES OF CALIFORNIA SEA LIONS DURING TRAINED SUBMERGED SWIMMING AND DIVING

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Since the bradycardia observed during trained head immersion of sea lions contrasts with the high heart rate (HR) recorded during flume swimming, we sought to examine HR during more prolonged submerged exercise in California sea lions (*Zalophus californianus*). Four subadults (30-40 kg body weight) were trained to swim submerged for 90-150 s periods while following an underwater target suspended from a cart moving at a 1.5m s^{-1} around a ring tank. A Holter monitor attached by a strap harness recorded the electrocardiogram (ECG). The same device was also used on sea lions trained to dive to a target as deep as 100 m in the open ocean. Heart rate was calculated beat to beat from the R wave interval of the analog ECG. Mean resting HR ranged from 60 to 130 beats/min (BPM). During submerged swimming (SS), mean submergence HR's were 40-80 BPM, surface HR's, 110-150 BPM. During dives between 80 and 185 s duration, mean HR's were 48-82; HR, as during SS, rapidly decreased to minimum rates of 25-50 BPM during the dive. These low HR's, which occur while the sea lion is actively swimming, imply a major restriction in blood flow distribution during SS and diving in sea lions. Supported by USPHS HL 17731.

A RAPID NON-INVASIVE TECHNIQUE FOR AGEING YOUNG HARBOUR SEALS.

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Where studies of Harbour seal pups extend throughout the year, it can be difficult to distinguish between some recently weaned pups and yearlings. Slow growth during the first year, and between year variations in growth rate mean that size and weight of weaned pups and yearlings can be very similar. For studies investigating pup development it is clearly essential to be able to distinguish between early age classes. We therefore sought a technique to quantify these differences, in order to avoid subjective distinctions based upon general appearance.

We collected hair samples from a standard site on the dorsal surface of harbour seals, ranging in age from 1 to 18 months. 10 hairs were selected at random from each sample and the width of each measured, 3mm from the tip. A mean width was calculated for each animal. Initial results indicate that the hairs of pups that have undergone their post-natal moult are significantly wider (mean=0.18mm) than those of animals less than 1 year of age (mean=0.11mm). Measurement of small quantities of hair therefore promises to provide a rapid non-invasive technique for quantifying the age of young harbour seals.

AMPLIFICATION OF INTERVENING NON-CODING SEQUENCES IN ACTIN GENES IN THE BELUGA WHALE (*DELPHINAPTERUS LEUCAS*)

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The beluga whale is of great cultural importance to many Canadians. Across the North the species is harvested by aboriginal peoples. These whales migrate, in early summer, from poorly defined wintering areas in broken ice cover to estuarine and other nearshore waters in the Arctic. An understanding of the genetic discreteness of the various summer concentrations of beluga is needed so that stocks can be clearly identified and managed on an individual stock basis. This requires not only the analysis of maternally inherited mitochondrial DNA (mtDNA) but also the establishment of nuclear DNA markers which may be used to determine the beluga breeding strategy. We have amplified nuclear non-coding intron sequences in beluga actin genes. Total DNA was extracted from skin samples collected during aboriginal subsistence harvests of beluga. The beluga intron sequences were then amplified using primers designed by S. Palumbi, University of Hawaii. In the beluga, four major amplification products have been identified in a 230 bp to 1.5 kb fragment size range. Three of these fragments have been successfully reamplified. Analysis of the size and nucleotide sequence of these intron amplification products provides data that may be used for investigation of nuclear genetic variability between beluga whale populations.

A FIELD STUDY OF THE SPRING MIGRATION AND HABITAT USE OF HARBOR PORPOISE (PHOCOENA PHOCOENA) IN THE PENOBOSCOT BAY AREA OF CENTRAL MAINE.

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In the spring of 1992 the National Marine Fisheries Service began a directed study of the habitat use, resource partitioning, and life history parameters of the harbor porpoise. The study of these ecological relationships centered in Penoboscot Bay and along the central Maine coastline. Three, one week study periods in April, May and June followed the arrival and residency of animals in the bay. Over 600 miles of transect lines were run using a RIB and 47 CTD stations were occupied. No animals were reported in the April survey in well mixed 4°C water. In May, in generally isothermal (9°C) conditions, 15 sightings were made of 18 individuals. In June, in waters stratified in both salinity and temperature, 99 animals were seen in 48 sightings. These animals were frequently seen in cow/calf pairs in the presence of a third animal. Sighting rates were greater in the western reaches of the bay where salinities were lower. This distribution is correlated with pelagic fish abundance.

THE USE OF A GEOGRAPHICAL INFORMATION SYSTEM TO CORRELATE DOLPHIN HOME RANGE WITH ENVIRONMENTAL FACTORS

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A study of bottlenose dolphins (*Tursiops truncatus*) in the Aransas Pass, Texas, area, was begun on 1 April 1991. One hundred forty three surveys from boat and land-based platforms resulted in 1,028 hours of direct observation of dolphins within a 45.6 km area of channels and inlets. Repeated sighting of three photographically identified individuals in three disparate areas indicate a preference for certain attributes such as tidal movements, sub-surface topography, water temperature, and water depth in preferred habitats. This poster will demonstrate the ability of GIS to integrate photo-identification studies and sighting information into map transects to correlate site fidelity and environmental factors.

EXPANSION OF THE NORTHERN ELEPHANT SEAL BREEDING COLONY AT POINT REYES HEADLAND, CALIFORNIA (1981-1992)

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Northern elephant seals began breeding at Point Reyes Headland in the early 1980's. A total of 116 pups were born during the 1991-92 breeding season. The number of northern elephant seal births at Point Reyes Headland have increased an average of 43% annually for the first 12 years of the colony. This growth rate is similar to, though slower than, the first 12 years of breeding at the neighboring Farallon Islands, as well as the mainland breeding site at Año Nuevo. Pup mortality was 6% in 1991-92 and has averaged 10.3% annually. During the 1991-92 breeding season, 19% of the breeding females were of known age and origin. Their ages ranged from 2-17 years and averaged 6.1 years. Of these females, 64% were born at Año Nuevo, 14% at San Miguel Island, 9% at the Farallon Islands, 9% were released by the California Marine Mammal Center, and 4% were born at San Nicolas Island. One of the two alpha bulls was of known age (8 years) and origin (Año Nuevo).

GREY SEALS (*Halichoerus grypus*) LEUCOCYTE RESPONSE TO CHANGES IN AMBIENT TEMPERATURES

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Unseasonably warm environmental temperatures have preceded a number of marine mammal epizootics. In the present study, leucocyte counts were monitored in adult grey seals (*Halichoerus grypus*) exposed to natural photoperiod and ambient air temperatures. Throughout the year, leucocyte numbers were negatively correlated with day length and with air temperature. To separate the effects of photoperiod and temperature, two adult animals were exposed to warmer temperatures for 4 weeks during winter, while the natural photoperiod was maintained. At the higher temperatures, white blood cell counts decreased and continued to do so for 4-5 weeks after the animals were returned to natural seasonal (i.e. lower) temperatures. Yet, when the experiment was repeated with two immature grey seals, which had been kept at relatively constant air and water temperatures since weaning, the opposite results were obtained. These preliminary results suggest that changes in temperature have an effect on pinniped immune systems and may be a potential contributing factor in marine mammal epizootics. They also suggest that changes in temperature may trigger different responses in seals of different ages.

COMPREHENSION OF CONJUNCTIVE RULES BY A BOTTLENOSED DOLPHIN

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A bottlenosed dolphin, *Tursiops truncatus*, was trained on two contrasting connective sequences in an artificial gestural language. The sequence OBJECT1 + "AND" + OBJECT2 + ACTION, required a response to both designated objects using the specified action. The contrasting sequence, OBJECT1 + "NO" + OBJECT2 + ACTION, required a response to only OBJECT2 using the specified action. After training, a transfer test was carried out with the new sequences: (1) MODIFIER + OBJECT1 + AND/NO + OBJECT2 + ACTION, and (2) OBJECT1 + AND/NO + MODIFIER + OBJECT2 + ACTION. The dolphin produced the correct response category (responding to both or responding to only the last object) on 93.8% (43/48) and 87.5% (21/24) of the novel AND and novel NO sequences, respectively. The dolphin's strategy was to respond to OBJECT2 first, and then respond to OBJECT1. Though choice accuracy on both OBJECT1 and OBJECT2 was generally above chance, accuracy on OBJECT1 in the AND conjunction was less than on OBJECT2. Similar performance differences have been observed for certain other language sequences also requiring the dolphin to remember and respond to two named objects (Herman et al., 1984). Performance was significant ($p < .00001$) on both the modified OBJECT1 and the modified OBJECT2. Results were interpreted in terms of comprehension of the semantic difference between AND and NO, memorial encoding of OBJECT1 and OBJECT2, and the comprehension of word-order.

EARLY PHASE OF NORTHERN FUR SEAL (CALLORHINUS URSINUS) PUP MIGRATION FROM ST. PAUL ISLAND, ALASKA

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The pelagic migration and distribution of weaned northern fur seal (Callorhinus ursinus) pups must be understood to identify those factors which may influence their growth and survival. The early phase of northern fur seal pup migration was investigated using VHF (very high frequency) radio telemetry. In 1989-90, 184 pups were radio-tagged on St. Paul Island, Alaska. After their departure from the island, pups were located near the eastern Aleutian Islands by automated receiver stations on land and aerial surveys from fixed-wing aircraft. Mean departure dates were November 13 (± 5.1 days sd, n=90) and 17 (± 4.9 days sd, n=88) in 1989 and 1990, respectively. Average travel time between St. Paul Island and the Aleutian Island passes was 11 days (± 6 days sd, n= 63). Estimated minimum traveling speed was 36-40 km/day in the Bering Sea and 57-61 km/day near the Aleutian Island passes (assuming movement in a straight line). Traveling speed and locations were not significantly different for males and females. Located pups were widely distributed throughout the Aleutian Island study area from Unimak Pass to Samalga Pass and remained dispersed as they migrated into the North Pacific Ocean. However, the relatively high proportion of pups in the study area indicates that migration from St. Paul Island was not random, but instead directed toward the southeast. These results indicate that after weaning fur seal pups may spend relatively little time in the Bering Sea.

USING DECISION ANALYSIS TO HELP CHOOSE AMONG MANAGEMENT STRATEGIES FOR ENDANGERED SPECIES

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Applying decision theory to conservation problems can provide practical new techniques for agency decision-makers. The use of these new analytical techniques can lead to better-documented, more defensible decisions and the wiser use of limited budgets.

We apply decision theory to the problem of choosing a management strategy to reduce deaths from "mobbing" in endangered Hawaiian monk seals. First, we develop a simulation model of a small monk seal population and use it to estimate the probable results of various management strategies. We then use the probabilities generated by the model as input for two simple multi-objective decision analysis techniques: hierarchical goal filtering and ranking on a weighted objective function. The two techniques give similar results.

Both techniques avoid the use of average outcomes and expected values, help focus discussion on objectives and goals, and are suitable for use in a workshop environment.

DISTRIBUTION AND HABITAT USE OF HARBOR PORPOISE (*Phocoena phocoena*) IN THE NORTHERN SAN JUAN ISLANDS, WASHINGTON.

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Within northern Puget Sound, Washington, harbor porpoise (*Phocoena phocoena*) numbers have declined in areas where once commonly observed. The objective of this study was to examine distribution and abundance patterns, and environmental variables potentially influencing areas of occurrence.

Random 8 km boat surveys (n = 73) were conducted from June to October 1992 in a Beaufort sea state of 0 or 1 between 0700-1900 h. The study area was sectioned into five approximately equal areas (46-55 km^2) to facilitate transect placement.

Porpoise were sighted on 75% of surveys. Of the 62.9 h of survey time, there were 301 sightings (526 porpoise). The distance from survey vessel to porpoise varied from 10-1083 m ($\bar{x}$ = 451.0 m, SE = 14.53). There was an average of 4.8 sightings per hour (9.0 porpoise/hour). Porpoise were distributed over a depth range of 20.1-235.0 m ($\bar{x}$ = 142.0 m, SE = 2.33), with 83% occurring over depths greater than 100 m and 65% occurring over bottom relief of less than 10 m. Groups of birds (>100) were associated only with 0.7% of sightings.

LIFE HISTORY & DIET OF HARBOUR PORPOISES IN THE GULF OF MAINE

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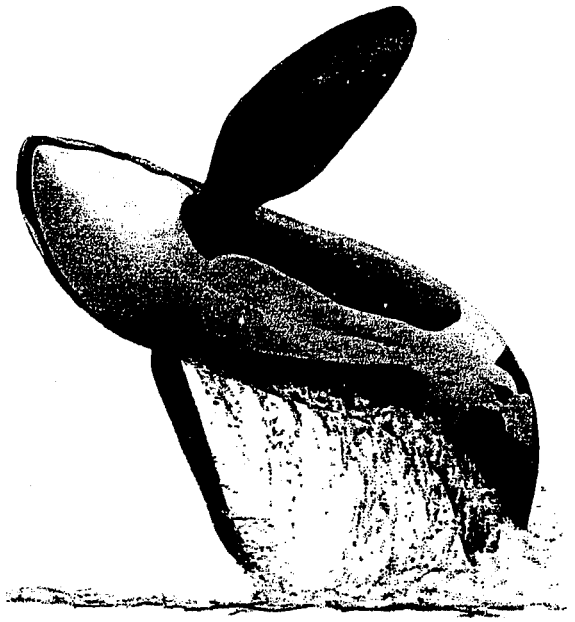
We examined age, reproductive condition and diet of 78 harbour porpoises (*Phocoena phocoena*) killed incidentally in Gulf of Maine fisheries between 1989 and 1993. Most specimens were killed in sink gill nets during spring and autumn, seasons for which there is little information on the ecology of this population. Age was estimated from decalcified and stained sections of teeth. Most specimens were young, but several older (>10 years) individuals were present in the sample. Histological testis preparations revealed that eight of 22 males were sexually mature, although testis size and function regressed considerably during the non-breeding season. Thirteen of 25 females were sexually mature; all but one were reproductively active. The apparent pregnancy rate was 0.85, consistent with other studies of reproduction in this population. The stomachs of 55 individuals contained 10,820 fish otoliths and 31 squid beaks. Two fishes dominated the diet: herring *Clupea harengus* (711 otoliths from 30 stomachs), and silver hake *Merluccius bilinearis* (3,133 otoliths from 30 stomachs). Two deep water prey species were identified: pearlsides *Maurolicus muelleri* (4,886 otoliths from 18 stomachs) and lanternfish *Ceratoscopelus maderensis* (1,921 otoliths from two stomachs). These last two species are new prey records and may be important in the diet during fall and winter, when porpoises may be found in deep water.



BODY CONDITION AND METABOLIC CHEMISTRY OF STELLER SEA LION PUPS IN THE ALEUTIAN ISLANDS AND GULF OF ALASKA.

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We measured body condition and metabolic chemistry of 74 Steller sea lion pups to test the hypothesis that neonatal pups are physiologically compromised, suggesting that they could not survive the first year foraging at sea. Pups were captured at 8 locations in the Gulf of Alaska and the Aleutian Islands during June and July of 1991 and 1992. Pups were weighed and blood samples collected from the pelvic venous plexus to determine hematocrit (Hct), hemoglobin (Hb) content, water content of the plasma and whole blood, and plasma concentrations of blood urea nitrogen (BUN), non-esterified fatty acids (NEFA) and ketone bodies (ß-HBA).

Pups ranged from 19.5 to 46.5 kg with a mean (± SD) of 31.0 (± 5.9) kg. Hct ranged from 29% to 51%, and there was a tight linear relationship between Hct and Hb concentration (r^2=0.68, p=0.000). Water content of the whole blood and plasma showed no indication of dehydration in these pups.

There was no apparent correlation of metabolic chemistry with the mass of the pups. ß-HBA concentrations ranged from 0.026 to 0.828 mM. However, this same range of values was seen within some individuals that were sampled again one week later, suggesting a wide variability possibly due to short fasts while the mother is at-sea foraging. BUN values were typically between 2 and 8 mM although some animals showed concentrations up to 14 or 16 mM. These levels are within ranges reported for other young pinnipeds. NEFA levels ranged from 0.3 to 5.93 mM with a mean of 1.47 (± 0.81).

We found no evidence that the Steller sea lion pups in this study were severely physiologically compromised such that their future survival would be impacted.

STATISTICAL CHARACTERIZATION OF BELUGA WHALE VOCALIZATIONS

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Until now, investigators of vocal behavior have been primarily limited to qualitative categorization of sounds based on aural impressions and visual inspection of spectrograms. Recent advances in computer hardware and software facilitate automated acoustic feature extraction, which in turn enables use of statistical techniques to test whether sounds fall into discrete categories.

Beluga whales (*Delphinapterus leucas*) produce a wide variety of sounds. Vocalizations of wild and captive belugas were analyzed both qualitatively and quantitatively to compare the resulting characterizations of vocal repertoire. In general, beluga whale calls did not fall into distinct categories. Differences were found in the vocalizations of groups of beluga whales at different captive facilities. These results will be contrasted with those from previous studies.

ORGANOCHLORINES IN MILK FROM VARIED STAGES OF LACTATION OF TRAINED TURSIOPS TRUNCATUS.
Reddy, Michelle and Sam Ridgway
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Organochlorines (OC) were analyzed from milk of 4 bottlenose dolphins trained to postition at penside to allow for milk collection. Samples were collected from SAY (age 12) and ELL (≈age 16) after each produced their first calf, from SLA (age 32) when she relactated 12 years after the birth of her first calf (relactation was induced after she was housed with an orphaned calf), and from TOD (age 35) who began lactating after being housed with an orphaned calf; she had not calved in the 24 years she has been cared for at NCCOSC. Data reflect levels at varied stages of lactation. The highest values (lipid wt.) for p,p'DDE, p,p'DDD, p,p'DDT, and PCB were 3.39, .215, .101, 2.74, (in PPM) respectively, and were found in milk produced by TOD, the oldest dolphin. The lowest values for p,p'DDE, p,p'DDD, p,p'DDT, and PCB were .33, .027, <.025, .0281, respectively, and were from milk produced by ELL, one of the youngest. Data suggest that OC levels: 1) are related to fat content of milk, 2) are gradually released throughout the course of lactation and, 3) are related to age and reproductive history.

CAN PUERTO RICAN MANATEES BE TRACKED FROM SPACE? THE FIRST SATELLITE-BASED TELEMETRY OF TRICHECHUS MANATUS OUTSIDE THE CONTINENTAL UNITED STATES
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Since 1985, Service Argos-monitored transmitters have been deployed on 75 Florida manatees to document habitat use and movement patterns. Recovery plans for West Indian manatees in Puerto Rico specify the need for telemetry-derived location data in order to develop effective management strategies. In 1992, Sirenia Project personnel initiated a study to determine the feasibility of capturing manatees in the open-waters of eastern Puerto Rico and the effectiveness of using existing manatee radio transmitters and tag attachments on manatees off Puerto Rico. With the cooperation of the U.S. Navy, Puerto Rico DNR, Caribbean Stranding Network and local USFWS offices, manatees were net-captured at Roosevelt Roads Naval Station where they frequent a freshwater discharge. Capture techniques used in Florida were modified to minimize complications at this open-water site. Three male manatees were radio tagged and tracked remotely through Service Argos. Location data were regularly obtained with units typically averaging 1.3 locations of quality 1 or better per day. In the field, manatees were located for behavioral observations and tag adjustments using VHF and ultrasonic telemetry techniques. Two had transmitters replaced after six months, enabling a 12-month continuous track on each. Use of the protected waters of the Naval Base was common for all three individuals. One also periodically traveled 10 km across open water to and from Vieques Island. Several modifications to the tag and attachment were made or identified to accommodate the marine environment of coastal Puerto Rico. Improvements in the tag design and success with monitoring manatees in habitats different than those encountered in Florida show promise for future satellite-based telemetry projects on manatees throughout their range.

DIVING PATTERNS OF HARBOUR SEALS PHOCA VITULINA IN THE SHALLOW WADDEN SEA ASSESSED BY VHF-TELEMETRY
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The activity patterns of harbour seals is investigated to reveal behavioural responses to a specific habitat type presented by the shallow Wadden Sea (average depth between 1 and 5 m). Covering different sex- and age-classes, the diving behaviour of 25 animals is monitored by means of VHF-telemetry.

The mean duration of dives varied among individuals between 1.5 and 4.75 minutes and was found to increase in relation to the body size. Comparing the frequency distributions of dive durations among size classes showed that, albeit medians are similar, larger seals performed a higher proportion of longer dives. The maximum dive duration was 31 minutes. It is remarkable that average dive durations of adult animals continue to increase exponentially in relation to the proportion of time spent submerged. While the percent dive time amounts to rates between 90 to 99.9%, the average dive duration is above 3 minutes. Mean percent dive times, found for harbour seals in the Wadden Sea was 87%, which exceeds the values reported for this species in other habitats by 10%. One explanation might be that seals adopt specific diving strategies in response to environmental parameters such as water depth and food availability

TASK-SPECIFIC CODING STRATEGIES IN A CALIFORNIA SEA LION
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The ability to quickly alter problem-solving strategies is important for an animal exposed to widely fluctuating environmental conditions. In order to assess the degree of such flexibility in a marine mammal, a California sea lion (Zalophus californianus) was presented with four variations of a visual problem-solving task. The animal was trained to match identical stimuli (identity matching-to-sample), as well as to relate pairs of non-identical stimuli (arbitrary MTS). In one condition (simultaneous), the subject's choices were made while the sample stimulus was exposed. In the second condition (delayed), the sample stimulus was removed before the two choice stimuli were revealed. While no significant differences were observed between the two conditions in arbitrary matching (90%+ correct response levels for both simultaneous and delayed), a significant decrease in performance in identity matching occurred between the simultaneous and delayed conditions. These results suggest that at least two problem-specific coding strategies were developed by the subject. We hypothesize that the subject shifted strategies between identity and arbitrary matching in order to economize on memory, utilizing the most efficient and appropriate strategy to solve each type of problem.

DEEP THROAT: THE ODONTOCETE HYOID APPARATUS AND ITS ROLE IN SUCTION, SWALLOWING, AND SOUND PRODUCTION
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Odontocetes show a number of aerodigestive tract specializations including a permanently intranarial larynx. While we are beginning to understand some of these, the comparative anatomy of a major element, the hyoid apparatus (HA), remains poorly known. This study examines the HA in 48 specimens of 10 genera collected post mortem from beach strandings. Results show that the odontocete HA displays many morphological differences compared with those of their closest terrestrial relatives, the artiodactyls. Odontocetes show a basic pattern with the HA divisible into two parts: a basal portion (basihyal and paired thyrohyals) and a suspensory portion (paired ceratohyals, epihyals, stylohyals, and tympanohyals) connecting the basal portion to the skull base. The basal portion is flattened dorso-ventrally and relatively large, thus providing a broad surface area for muscle attachments. The basal elements are joined by a synostosis and lie inferior to the laryngeal aditus. The suspensory elements are not as flattened, and are joined by synovial joints (except for fusion of epihyal and stylohyal). The most pronounced differences from the basic pattern are observed in two families: 1) Physeteridae (*Kogia breviceps, K. simus,* and *Physeter catadon*) exhibit the flattest basal portion, while 2) Ziphiidae (*Mesoplodon mirus* and *M. europaeus*) exhibit a cylindrical basal portion and the flattest stylohyals. The derived position and shape of the odontocete HA may have evolved to subserve several specialized upper respiratory/digestive tract functions. For example, the intranarial position of the larynx may be maintained during HA depression, thus permitting simultaneous feeding (suction and swallowing) and sound production.

ANALYSIS OF LIFE HISTORIES OF FEMALE NORTHERN ELEPHANT SEALS: IMPLICATIONS FOR SENESCENCE THEORY
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The aim of this study was to examine the reproductive histories of long-lived female northern elephant seals, Mirounga angustirostris, in order to assess changes in reproductive success and reproductive effort with successive breeding attempts and age. The sample was composed of 109 known-age females (3-19 years old) that gave birth at Año Nuevo, California, 5 to 15 times in their lives, during the period, 1972 to 1993. Variables analysed were: fecundity, weaning success, mass of pup at weaning, and pup sex. Preliminary analysis indicates that reproductive success, pup mass and sex ratio did not vary systematically with successive breeding attempts. These findings have important implications for senescence theory and life history theory.

GENETIC STUDY OF SOCIAL ORGANIZATION IN SPERM WHALES
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As part of ongoing studies of groups of sperm whales (Physeter macrocephalus)found off the Galapagos Islands and mainland Ecuador, we have collected 517 sloughed skin samples for genetic analyses. Of these, 166 samples are from 4-5 distinct social groups (delineated from photo-I.D. records), while another 33 are from two large surface interactions. Eleven identified individuals with skin samples display long-term (up to 4 yrs) associations with other sampled individuals. We are scoring the genotypes of samples at PCR-amplified microsatellite DNA markers. Reliable estimates of genetic relatedness require extensive variation in allele frequencies within and between groups; some of our markers appear in fact to be highly variable with at least 12 alleles and hetero-zygosity approaching 90%. Apart from underlying genetic effects, some aspects of social structure appear to be sex-related. We have thus sequenced a fragment of the sex-specific SRY locus in the sperm whale, allowing us to determine group sex ratios by PCR analysis of this marker in different skin samples. Finally, we have extended previous statistical analysis of social patterns by examining temporal associations within distinct social units derived from photo-I.D. records (1985-1991). Individual whales did not appear to associate preferentially with specific members of their unit, but when two different units mixed temporarily, associations tended to be stronger within units than between.

GROWTH OF HARBOUR PORPOISE IN SOUTHEASTERN NEWFOUNDLAND, CANADA
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Although relationships among harbour porpoise (*Phocoena phocoena*) in the northwest Atlantic are unknown, it has been postulated that there are 4 local populations: Bay of Fundy/Gulf of Maine, Gulf of St. Lawrence, Newfoundland, and west Greenland. Data on the Newfoundland population is extremely limited. To determine if these animals can be differentiated from others on the basis of growth characteristics, 94 porpoise caught incidentally in fishing gear along the southeast coast of Newfoundland during the summers of 1990 and 1991 were examined. Most porpoises (56%) were ≤4 years of age. Maximum age was 9 for females and 12 for males. Growth rates were similar for both sexes until one year of age, after which females grew longer and weighed more than males of similar ages. Using the Gompertz growth model, asymptotic values for body length were 156.3 cm for females and 142.9 cm for males. Asymptotic weights were 61.6 kg and 49.1 kg for females and males respectively. Both male and female porpoise from Newfoundland were similar in length to porpoise from the Bay of Fundy and Norway. Females were heavier than those from Norway although males from the two areas were similar in weight. Although Newfoundland porpoise could not be differentiated from porpoise collected in other areas, differences in dental deposition patterns suggest that they may be an independent stock.

LACTATE DEHYDROGENASE ACTIVITY IN THE HEART MUSCLE OF DIVING MARINE MAMMALS AND TERRESTRIAL MAMMALS
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During periods of anoxia anaerobic glycolysis is activated and lactate dehydrogenase produces lactic acid and protons. The longest diving duration (breath hold period) for a marine mammal has been recorded at 2 hours. The possible differences between lactate dehydrogenase in the heart tissue of terrestrial and diving marine mammals was examined. Biochemical assays were done to compare LDH activity. Histological analysis was performed to compare localization of LDH. Lactate dehydrogenase activity was measured spectrophotometrically under normal atmospheric pressure and at 136 atm (equivalent to a 1360 m dive). Localization of lactate dehydrogenase was assessed using histochemical techniques which include fixation in 1% paraformaldehyde solution, dehydration in acetone and embedding in glycol methacrylate resin at 4 C. Possible biochemical adaptations to extreme pressure were considered. Results from terrestrial and marine mammals were compared to determine how the heart muscle of marine mammals withstand periods of ischemia and possible hypoxia as well as extreme changes in pressure.

REPRODUCTIVE PARAMETERS OF BOTTLENOSE DOLPHINS IN SHARK BAY, WESTERN AUSTRALIA
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Reproductive parameters of individually identified bottlenose dolphins resident in Shark Bay, Western Australia were estimated from nine consecutive years of sighting data (61-156 sighting-days per year). Births were concentrated in the spring and early summer, i.e., September to January (83% of 36 births known to within two months). Most of the remainder occurred from February to May and were usually late conceptions associated with the death of a newborn during the breeding season.

Interbirth intervals were a minimum of four years when the infant survived. Many were longer. The mean interbirth interval with a surviving infant was 4.9 years (14 intervals). All intervals of three years or less were due to infant mortality (17 intervals). When the infant died the mother generally became pregnant the following breeding season or late in the same season.

Infant mortality was high. Calculations with different criteria for the number of infants at risk yield similar results. One method estimates 31% mortality in the first year (26 of 83 newborns died in year one) and a cumulative mortality of 49% by year four.

RE-LACTATION AND INDUCED LACTATION IN *TURSIOPS* AND ANALYSIS OF MILK COLLECTED WITH A DOLPHIN MILKING DEVICE.
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Two non-lactating, non-gravid female bottlenose dolphins *Tursiops truncatus* (SLA, age 32 and TOD, age 35) began lactating 6 to 12 days after being put with orphan calves. SLA had been dry for almost 11 years since weaning her calf. TOD had never calved in 24 years at our laboratory. Using a modified human breast pump, the trained dolphins were milked at intervals. The first milk collected from these surrogate mothers, on day 8 from TOD and day 12 from SLA, contained 6.0 and 9.1% fat respectively. After 42 to 69 days the fat content increased to 20 - 26.5% which is similar to that of other dolphin milks reported. TOD nursed an orphan for 120 days after which the calf went totally on a fish diet. SLA nursed an orphan for nine months (and nursing continues) providing all of its nutrition for five months.

KILLER WHALES (*ORCINUS ORCA*) IN THE GULF OF MEXICO
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The killer whale was thought to be extremely rare in the Gulf of Mexico. Prior to 1989, there were only six verified Gulf records (4 strandings and 2 sightings). In 1989, the SEFSC began aerial and ship marine mammal surveys of the oceanic U.S. Gulf (>200 m). Since then, nine killer whale sightings have been made. The seven pods we sighted ranged in size from 8-13 whales and all had at least one adult male and, except for one, a calf among them. Pods were at depths from 732-2,689 m. Dorsal fin photographs indicate at least two distinct pods were sighted and one pod was sighted at least twice. This pod was sighted one day and again 27 hours later 111 km away from the initial sighting. Killer whales may have an oceanic distribution in the Gulf. Ten of the 11 total Gulf sightings were in oceanic waters. Extensive aerial surveys of Gulf shelf waters (<200 m) have resulted in no sightings. Eight of the 11 sightings were in the north-central Gulf. One sighting was made off Texas and two off central Florida. All sightings were made from May-September. However, this may be a result of increased survey effort during that time period.

RECORDS OF ANTARCTIC AND SUBANTARCTIC FUR SEALS IN ARGENTINA

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The southernmost species of fur seals that inhabit the Southern Hemisphere, Arctocephalus gazella and A.tropicalis, are island-breeders, the former close or south of the Antarctic Convergence (AC) and the latter north of it.

Only few A.gazella vagrants have been recorded north to the AC and most of them were in South America. We report here the first record of an Antarctic fur seal in Argentina, which was found in Mar del Plata (38°31'S) on November of 1989.

Numerous A.tropicalis vagrants were recorded in the Southern Hemisphere, but the information from Argentina was limited to a single record. From 1989 to 1992, 11 individuals were found between San Clemente (36°18'S) and Mar del Plata.

More than 90% of the world population of A.gazella breeds in South Georgia and some animals may reach South America; the finding in Tierra del Fuego of an animal tagged in this colony confirmed this potential route. These animals could be driven northbound by the Patagonian or the Malvinas-Falkland Current and reach northern Argentina, Uruguay and southern Brazil. Almost all A.tropicalis vagrants in the SW Atlantic Ocean were found between 10-40°S, in close relation with the Brazil Current; about 80% of the records are concentrated between 30-40°S, where a recirculation cell of this current is located. The source of these vagrants is probably Gough Island, and the animals may reach South America driven by the anti-clockwise South Atlantic Gyre, a surface transportation route confirmed by oceanographic drift cards and buoys.

RECENT HISTORY OF THE STELLER SEA LION POPULATION AT SOUTHEAST FARALLON ISLAND, OFF CENTRAL CALIFORNIA

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Since 1971 the presence of Steller sea lions (Eumetopias jubatus) has been counted by PRBO biologists at Southeast Farallon Island (SEFI). Beginning in 1977 biologists differentiated among bulls, cows, and subadult/immatures, and pups were counted during the spring and summer months. Haul out areas ranged from 0.3 to 1.2 km from the observation platform at the island lighthouse, which was 102 m above sea level. Approximately 75% of the island and 95% of the sea lion's haul out areas were visible from the lighthouse.

Over the past 20 years the numbers counted at SEFI ranged from 7 (in 1971) to 291 (in 1985). Peak numbers at the island occurred November 1985 and April 1977, 291 and 235 individuals, respectively. Over the past ten years (1983-1992) the mean number of sea lions counted during the winter months was 102; spring 143; summer 140; fall 174. The island population increased between 1971 and 1985 and has since shown a slow decline in numbers, primarily cows. The highest number of pups (16) was counted in 1977; 9 pups were counted during the 1992 summer. We speculate that some of these pups were not born at the island but arrived during August through the fall months. Photogrammetry was conducted in 1992 and '93. Preliminary data indicate that 30% of the population are missed in the counts conducted from the lighthouse.

COOLED ABDOMINAL AND EPIDURAL BLOOD IN DOLPHINS AND SEALS: TWO PREVIOUSLY UNDESCRIBED THERMOREGULATORY SITES

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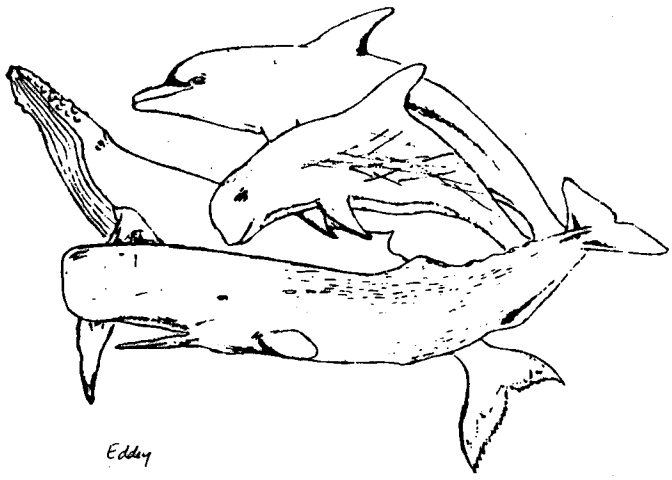
Reproductive systems in cetaceans and phocid seals are surrounded by thermogenic muscle and insulating blubber. This suggests elevated abdominal temperatures which, in terrestrial mammals, can produce developmental anomalies. Thermogenic muscles also surround much of the vertebral column, suggesting elevated temperatures in the spinal cord particularly during the ischemia of prolonged dives. In terrestrial mammals, changes in temperature of the spinal cord can effect firing rates of central and sympathetic nerves, and elevated temperatures damage central nervous system tissue. We offer anatomical evidence that cooled blood is available for (1) heat exchange in the reproductive tract preventing thermogenic anomalies in pregnant cetaceans and phocid seals, and (2) heat exchange in spinal retia of cetaceans and epidural sinuses of phocid seals and regulating central nervous system temperatures. These anatomical data offer insights into novel thermoregulatory mechanisms employed by diving marine mammals.



THE LAST CAPTIVE DOLPHIN IN BRAZIL: A PROJECT OF REHABILITATION, RELEASING , AND MONITORING IN THE NATURAL ENVIRONMENT.

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A male bottlenose dolphin *Tursiops truncatus* was reintroduced in its natural environment by a project of rehabilitation conducted in the beginning of 1993. The animal, maintained in a tank for exhibition purposes since 1984 in São Vicente, São Paulo state, was transfered to the probable capture site, in Laguna, Santa Catarina state (28°30'S, 48°45'W). In a corral specially made for this aim the dolphin went through some rehabilitation techniques, receiving only live fish and having all its behavioral as well as acoustic responses regularly monitored during exactly 44 days. So as to accompany the dolphin's movements and assure its identification after releasing, a losangle shaped freeze-brand was applied to both sides of the dorsal fin. After being released, the dolphin remained in the Laguna region for only 13 days, afterwards moving north and having travelled aproximately 155 miles (250 km) in 4 months. The movement pattern seems to be the following: the bottlenose has always remained in specific sites of shallow water, sometimes interacting closely with local people. It has also been observed occasionally together with one or two dolphins, at times involved in contests, what could explain the conspicous toothrakes the dolphin shows in the left flank. This piecework has provided opportunities to discuss many subjects like distortions in the relation man-wildlife and the ethics in the commerce, hunting and misapropriation of wild animals. A brazilian decree law dated of 1986 prohibits the capture, maintaining and exhibition of marine mammals in captivity.

A MOLECULAR PHYLOGENY FOR THE PHOCOENIDS: CONFLICT AND CONGRUENCE WITH MORPHOLOGY

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Portions of the control region and cytochrome b gene of the mitochondrial DNA molecule were sequenced to investigate the systematic relationships among the six species of true porpoises, family Phocoenidae. The phylogenies produced by the two gene regions are in agreement, with the exception of the position of one species, the harbor porpoise, Phocoena phocoena. Both mtDNA regions support: 1) the tropical species, Neophocaena phocaenoides, as the most basal member of the family; 2) a close relationship between Burmeister's porpoise, Phocoena spinipinnis, and the vaquita, Phocoena sinus; 3) association of P. spinipinnis, P. sinus and Australophocaena dioptrica. This last result is not in concordance with a recent morphological reclassification of A. dioptrica and bears further study.

SEASONAL SHIFTS IN THE ENERGY BUDGETS OF HARBOUR SEALS.

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Large seasonal changes in the mass and energy intake of harbour seals have been previously documented. Contrary to expectations, longterm studies of captive animals indicated that the postmating period of increasing hyperphagia occurred with parallel losses of up to 59% of maximum mass. Increases in body mass during the fall and winter were observed despite decreases in food intake. In the present study, ultrasonic blubber measurements confirmed the expectation that almost all of the mass changes could be accounted for through changes in the external blubber reserve. Further studies of circannual variance in rectal temperatures (up to 2°C) and activity patterns suggested that these observed changes in energy balance may be the result of shifts in metabolic demands. The metabolic rates of six harbour seals were measured every four weeks over the course of a year. Animals were kept in a metabolic tank for up to 24 hours. Activity patterns were monitored during the trials to ascertain their possible influence on oxygen consumption. Activity levels accounted for a portion of the observed seasonal shifts in metabolism. However, even after removing its effect, large differences in metabolic rates were still observed over the course of the year.

INHERITANCE OF VENTRAL FLUKE PIGMENTATION PATTERNS IN HUMPBACK WHALES (*Megaptera novaeangliae*) IN THE SOUTHERN GULF OF MAINE.

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Previous studies have illustrated heritability of pigmentation patterns in cheetahs, horses, and certain species of birds. It has been suggested that the pigmentation patterns of cetaceans, particularly the saddle patch of killer whales (*Orcinus orca*), are heritable characteristics. We report the inheritance of specific types of ventral fluke pigmentation patterns of humpback whales (*Megaptera novaeangliae*) in the southern Gulf of Maine. Ventral fluke pigmentation patterns of mothers and calves were ranked on a 1 to 5, white to black, scale. The pigmentation patterns of mothers were compared statistically to (i) all calves regardless of sex, (ii) male calves, and (iii) female calves. A parent-offspring test revealed a significant correlation in fluke pigmentation between mothers and their respective calves ($F_{1,158}$=.166, p<.05). When fluke pigmentation patterns of calves were randomly paired with mothers, there was no significant correlation in pigmentation ($F_{1,158}$=.125, p>.05). Pigmentation patterns of mothers compared to fluke patterns of twenty-nine female calves revealed a highly significant relationship ($F_{1,29}$=.4491, .005>p>.0025). A comparison of fluke patterns of forty-seven males with those of their mothers was not significant ($F_{1,47}$=.0507 p>.25). Given the maternally directed fidelity to specific feeding grounds that is known to occur in this species, heritability of ventral fluke pigmentation provides the basis for the observed geographic variation in these patterns.

IMPAIRMENT OF NON-SPECIFIC IMMUNE RESPONSES IN HARBOUR SEALS (Phoca vitulina) FEEDING ON FISH FROM POLLUTED WATERS

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The 1988 morbillivirus-induced mass mortality of harbour seals in Europe led to speculation about possible pollutant-induced immunosuppression in affected animals. During a two-year period, we monitored immune function in two groups of harbour seals being fed fish originating from polluted and non-polluted areas. Natural killer cell activity, an important first line of defence against viral infections and tumours, was measured by a chromium-51 release assay using YAC-1 as target cells. Phagocytic activity of neutrophils, an important first line of defence against bacteria, was measured by the ability of seal leukocytes to ingest and kill opsonized E. coli bacteria. While the phagocytic activity of neutrophils varied, natural killer cell activity was significantly and profoundly reduced in the seals fed the contaminated herring. This first demonstration of impairment of non-specific immunity in marine mammals as a result of contaminants accumulated through the food chain supports the idea of a contributory role of pollution in the 1988 epizootic in Europe, and may have relevance for other recent mass mortalities.

THE DIET OF HOODED SEALS IN NEARSHORE WATERS OF NEWFOUNDLAND, CANADA

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The diet of hooded seals (*Cystophora cristata*) was determined by reconstructing the stomach contents of 72 seals collected from nearshore waters of Newfoundland between 1987-91. The relative importance of food items were determined based on their contribution to total estimated wet weight and energy. Fourteen prey groups (10 fish, 4 invertebrate) were identified. Greenland halibut (*Reinhardtius hippoglossoides*) was the most important prey species, accounting for 42% of the total wet weight and 53% of the energy obtained. Also important, were redfish, *Sebastes spp.* (20.6% weight, 17.2 energy), Arctic cod, *Boreogadus saida* (14.5% weight, 11.2% energy), Atlantic herring, *Clupea harengus* (14.0% weight, 16.5% energy), squid, *Gonatus spp.* (7.2% weight, 0.8% energy), Atlantic cod, *Gadus morhua* (1.2% weight, 0.9% energy) and capelin, *Mallotus villosus* (0.3% weight, 0.4% energy). With the exception of Arctic cod, all are commercially important species.

Regressions between otolith size and fish length were developed for the major species consumed. Hooded seals fed primarily on 15-35 cm long prey. For most species, these size ranges are smaller than those taken by the commercial fishery.

SATELLITE-MONITORED MOVEMENTS AND DIVE BEHAVIOR OF A BOTTLENOSE DOLPHIN (TURSIOPS TRUNCATUS) IN TAMPA BAY, FLORIDA: A PILOT STUDY

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The purpose of this pilot study was to test the feasibility of using satellite telemetry to remotely document movements and dive behavior of a small cetacean. An adult, female bottlenose dolphin (Tursiops truncatus) was monitored 24 hours a day from 28 June to 23 July 1990, in Tampa Bay, Florida.

A total of 794 transmissions were received through the Argos Data Collection and Location System during 106 passes of two polar orbiting NOAA TIROS-N weather satellites. On average, 32 transmissions were recorded per day, with 7.5 transmissions per satellite pass. All detectable errors (19%) were omitted from data before performing analyses. An average of four locations per day were obtained and showed the animal generally remained close to the southeastern shore of the bay. A total of 63,922 dives were recorded. The animal spent 87% of the time submerged, with an average dive duration of 25 s. Data were collected and summarized into four, six-hour periods per day: early morning, day, afternoon/evening, and night. Average dive durations differed significantly among the four periods (ANOVA $p < <0.001$). During the early morning the average dive duration was 22 s, and the animal was submerged 82% of the time. In contrast, during the afternoon/evening the average dive duration was 32 s, and the animal was submerged 93% of the time. When captured, the dolphin was accompanied by a five year old "calf." The tagged dolphin was resighted numerous times in the presence of other dolphins, including the calf. The dolphin was photographed four months after tag loss, and there was no evidence of damage to the dorsal fin.

Results demonstrate that satellite telemetry can be an important, cost-effective means of collecting data about small, free-ranging cetaceans.

SURVIVAL AND REPRODUCTION OF ADULT, DEPENDENT AND WEANLING SEA OTTERS IN PRINCE WILLIAM SOUND AFTER THE T/V *EXXON VALDEZ* OIL SPILL

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To determine effects of the T/V *Exxon Valdez* oil spill on sea otters, adult female (n = 96) and dependent (n = 64) sea otters were captured in Prince William Sound, instrumented with radiotransmitters, and monitored between October 1989 and November 30, 1991. Individuals in the oil spill area were compared to their counterparts in the eastern Sound. Data were also available from 104 sea otters instrumented in Prince William Sound before the spill.

Adult females in eastern Prince William Sound exhibited a lower survival rate than those in the western Sound. No differences were observed between pupping rates, or between survival rates to weaning of dependent pups, of sea otters in the two areas. Survival rates of weanlings over their first winter were significantly lower in the oil spill region than in the eastern Sound.

These data are important to understanding the overall extent of damage to the affected sea otter populations; to estimating the rate and pattern of recovery of the populations studied; and thus, to formulating current and future restoration and response activities.

POLAR BEAR REACTIONS TO ICEBREAKER OPERATIONS ASSOCIATED WITH OFFSHORE DRILLING EXPLORATIONS

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The response of polar bears to icebreaker operations associated with offshore drilling exploration was monitored opportunistically during summer 1991 at two remote oil prospects in the Chukchi Sea. A total of 46 bears (including 6 cubs) in 34 groups were sighted from an Arctic Class 3 icebreaker for periods ranging from a single, brief sighting to 16.1 hr (mean = 1.6 hr). Focal animal sampling was used to describe the behavior of polar bears. Bears were under continuous observation from the icebreaker for a total of 38.4 hr and spent most of their time resting/sleeping (64%), followed by walking (28%), swimming (7%), running (<1%), and actively feeding (<1%) at distances ranging from 150-3,500 m. Bear reactions to the icebreaker were variable and generally of short duration. Half (17) of the 34 groups showed no or slight (attentive and watching) interest toward the icebreaker while it was drifting, icebreaking, or transiting; 6 groups approached it out of apparent attraction/curiosity primarily while it was drifting; and 5 groups slowly walked or swam away. The remaining 6 groups broke into a short (<500 m), brief running sprint away from the vessel, after which they resumed walking or resting. Bears moved away from the vessel primarily while it was transiting, icebreaking, or moving ice. Most bears appeared to habituate to the presence of the icebreaker, and avoidance responses were brief relative to the period bears were within view of observers.

POX-LIKE MARKS ON THE BACKS OF SOUTHERN RIGHT WHALES, EUBALAENA AUSTRALIS

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Every year since 1971 we have photographically surveyed the population of southern right whales at Peninsula Valdes, Argentina. In the early 1980s we began to notice oval marks on the backs of some individuals, and the incidence of such marks appears to be increasing. The marks are large (5-15cm), concave and whiter than newly peeled skin. In 1975, 5 out of 99 adults (5%) had these marks. A decade later, more than 5 times as many individuals had such marks (23% of 105 adults in 1986, 28% of 90 adults in 1987). We have reanalyzed our photographs for the number and location of oval marks on all whales represented by images of high quality in a number of years throughout the study. A whale can have from one to as many as 20 marks. They are confined to the back in the region exposed to air as the whale surfaces to breathe. They are more frequent in females than males. Of the 24 whales with marks in 1986, 80% were females, none were known males. They also occur on calves. The marks remain for at least weeks but do not appear to last between breeding seasons. So far we have been unable to collect skin samples from oval marks.

SPOTTED SEAL SUMMER DISTRIBUTION AND ABUNDANCE IN ALASKA

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Spotted seals (*Phoca largha*) of the Bering Sea haul out on isolated mud flats and sandy beaches along the western coast of Alaska in the summer when sea ice is absent. Concern for this species has risen with the large declines in neighboring populations of Steller sea lions (*Eumetopias jubatus*), harbor seals (*Phoca vitulina*), and northern fur seals (*Callorhinus ursinus*). Furthermore, because spotted seals are often misidentified as harbor seals, the degree of take in fisheries is probably underestimated. During 16-24 August 1992, we conducted the first dedicated summer search for spotted seals along the Alaskan coastline from Bristol Bay to Point Barrow. All previous spotted seal surveys in the U.S. occurred more than 15 years ago and were over the spring sea ice, except recent summer studies at Kasegaluk Lagoon in the eastern Chukchi Sea. We surveyed in a Twin Otter aircraft mostly at altitudes of 150-200 m, but seals startled even when our altitude was as high as 1,370 m and we were still several kilometers away. Concentrations of seals were found in Kuskokwim Bay (3,300), Scammon Bay (420), Golovnin Bay (52), Cape Espenberg (73), and Kasegaluk Lagoon (300); all sites that have been used historically. In contrast to the spring when groups of only 1-3 seals haul out on sea ice, haul sites in summer had no fewer than 50 and up to 750 seals in dense aggregations. Our total count of 4,145 seals does not include animals at sea, on Russian coasts, or on islands in the central Bering Sea. Additional information is to be gained through satellite tagging, as done by the Alaska Department of Fish & Game, before population abundance and trends can be projected from counts of hauled out animals.

Phocine Distemper Virus (PDV) in New York and the Relation Between Titers, Pathology and Viral Presence.

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During 1991- 1993 harbor (*Phoca vitulina*), hooded (*Cystophora cristata*), and harp (*Phoca groenlandica*) seals were recovered with clinical symptoms similar to those described during a 1988 distemper outbreak in Northern Europe. Serum from these animals was tested to PDV-1, CDV, PPRV, and MV using a serum neutralization method. Samples were also tested by immunofloresence assay to CDV. Those animals that died or were euthanized were examined for histologic lesions characteristic of distemper and special stains were used to identify PDV viral particles.

A comparison of those animals having low titers, VN <1:128 to those with high titers <>1:256, including the hisopathology, indicated a significant difference. Seals with low titers were found to have lesions consistent with a morbillivirus infection and/or virus particles were observed. Animals with high titers were found to be lacking both histologic lesions or viral particles. In addition, one seal that has been tested for almost two years has never demonstrated any clinical symptoms. Virus isolation attempts have been unsuccessful and this animal continues to remain healthy.

Based on our studies it appears that the Phocine Dispemper Virus, like most other morbillivirsues, confers long term immunity. Therefore, the animal with a high titer may not shed the virus. Conversely, animals still shedding the virus would be those with low, unstable virus neutralization titers.

MEXICAN HUMPBACK WHALES, Megaptera novaeangliae, REPRODUCTIVE PARAMETERS AND COW AND CALF RELATIONSHIPS.

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The present study contribute to the knowledge of the reproductive cycle of the Humpback whale in Mexico. Between 1986 and 1992, 46 females were photoidentified in Isla Socorro, Archipiélago de Revillagigedo, Colima, with a total of 68 calves; on the other hand, 21 cows were identified with the same number of calves in Bahía de Banderas, Nayarit-Jalisco. The birth rate average was 0.103 (10.3%) in Isla Socorro and that calculated for Bahía de Banderas was 0.081 (8.1%). Calving intervals only could be calculated for Isla Socorro with an average of 2.1 years. The estus post-partum with conception was considered in 35% (7) of the total cases in Isla Socorro, which allowed the conclution that at least the population of this area is still recovering. On the reproductive areas the cows and calves were accompanied for one or more adults whales in a high percentage (55%). In both study areas were clearly observed that the active surface groups with calves increase as the season advance, while the active surface groups without calves decrease along the time, which showed that the active surface groups gave attention to the females that did not give birth and then those that did.

EFFECTS OF RESEARCH BOAT APPROACHES ON HUMPBACK WHALE BEHAVIOR OFF MAUI, HAWAII, 1989-1993

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This study describes humpback whale (*Megaptera novaeangliae*) responses to close approaches by a research boat operating under federal permit for the purpose of obtaining identification and behavior photographs. The study period covered the months of January through March, 1989-1993, in the Auau Channel off Maui, Hawaii. Responses to approaches inside 100m were logged as (1) evasive, (2) investigative (non-threatening investigations of the boat), and (3) agonistic reactions. The winter season was divided into two-week segments for analytical purposes. Pods were classified as small (1-2), medium (3-4), or large (5+) in size. Pod composition included adult-only (AO), cow-calf (CC), cow-calf-escort (CCE), and cow-calf-multiple escort categories.

Out of 1020 pods approached by our research boat, whales responded only 137 times (13.6%; X^2=547.1, $p < 0.0001$). Evasive reactions constituted 63 of the responses (6.6%). There were 54 investigative approaches (5.3%) and 16 agonistic reactions (1.6%). Variations of specific responses by years of the study were not significant. Responses were not significantly associated with the time of the winter season ($p < 0.683$), although there was a surge in the number of reactions during the first two weeks of March (n=39, 28.5% of all reactions). Responses were associated with pod size (X^2=18.3, $p < 0.001$) and pod composition (X^2=25.3, $p < 0.0003$), wherein investigative approaches generally involved small or medium sized AO pods, and agonistic reactions were primarily exhibited by escorts in CCE pods during early March.

THE HUMPBACK WHALES (Megaptera novaeangliae) AT ISLA SOCORRO, ARCHIPIELAGO REVILLAGIGEDO, MEXICO. 1986-1992.

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Humpback whales were studied during the winters from 1986 to 1992 in Isla Socorro, México. Observations were made from small boats; photoidentification and sounds recording techniques were used. From a total of 1157 sightings 10.4% correspond to cow-calf pairs (C-c), 9.2% to cow-calf-escort groups (C-c-e), 3.5% to groups containing 3 or more adults with calf (A-c), 20.5% to groups of 3 or more adults (A), 32.6% to pairs of adults (P), 16.1% to single whales (S) and 7.7% to singer males (SM). All the social groups were present throughout the season but with different maximum of sightings; from mid-February to mid-March for the C-c pairs, from early February to early March for the P, from early to late February for the S and from early February to mid-March for the A. The C-c-e and A-c groups increase as the season advance with a peak in early April. The SM were constant during all the season (January to April). 511 whales had been photo ID, 106 of these were resighted in the study area in different years and only 13 along the mexican mainland coast, showing a high fidelity for the Revillagigedo breeding ground. The maximum staying time recorded was 63 days for a whale registed in 10 different days.

HUMORAL IMMUNITY IN NORTHERN ELEPHANT SEAL *Mirounga angustirostris*. MOTHERS AND THEIR PUPS

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The Northern elephant seals' (NES) dominance-based polygyny, aggregate breeding behavior and breeding site fidelity provides a unique model for studying pinniped immunology. Molecular studies suggest significant monomorphism within this species, which could be exacerbated by close inbreeding, and may leave NES susceptible to epizootics. An immunological investigation is underway to assess the immune status of the population. Monoclonal antibodies specific for phocid immunoglobulins, IgM-like H1a and 2 IgG-like subclasses H24b and H49a, were used to measure early and late lactation IgG and IgM levels in the milk and serum of free ranging adult females and the serum of their pups. Total IgG in the milk did not increase significantly and IgM levels decreased by 50% (21.08 ± 6.0 µg/ml to 15.08 ± 2.5 µg/ml) over the 20-day interval. IgG subclasses in nursing pups' serum were similar at 3 days post-partum (PP) but differed significantly by 23 days PP (15.3 ± 9.8 mg/ml vs 6.43 ± 2.09 mg/ml, $p < 0.05$ for H24b and H49a respectively). IgG in female sera decreased by 39% from early to late lactation; however, IgM increased significantly (0.725 ± 0.076 mg/ml to 1.19 mg/ml ± 0.262 mg/ml, $p < .001$). Pup IgM levels increased two-fold from 64% of adult levels at 3 days to 83% by 23 days PP. These results show significant *in utero* IgM antibody synthesis by pups and possible immunological challenge associated with reproduction in the females. Milk IgG levels suggest a minor role for this class in early neonatal immune protection. (Supported by NIGMS-MBRS RR 01882)

CALVING INTERVALS OF THE HUMPBACK WHALE (*Megaptera novaeangliae*) OFF THE OGASAWARA ISLANDS

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Waters off the Ogasawara (Bonin) Islands (27°N, 142°E) have been known one of the winter breeding ground for humpback whales (*Megaptera novaeangliae*) in the Western North Pacific. Over 400 individual humpback whales have been photographically identified in nearshore waters off the Ogasawara Islands from 1987 through 1993. A total of 45 identified cows were associated with 55 calves during the 7 research seasons. Nine cows were recorded with a calf in different two or three seasons. Observed mean resighting interval of identified cows with calves was 2.3 years (n=10, SD=0.78); 1 year (n=1), 2 years (n=6), 3 years (n=2), 4 years (n=1). This means that calving interval existed around the interval above. Two of identified 12 calves were resighted in the subsequent year, and one of them still stayed with its cow. This may indicate the longest suckling period of the group.

QUANTITATIVE BEHAVIORAL STUDY OF BOTTLENOSE DOLPHINS IN SWIM-WITH-DOLPHIN PROGRAMS

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The four Swim-With-Dolphin (SWD) programs in the United States presently operate under temporary captive display permits, pending determination by National Marine Fisheries Service (NMFS) whether these programs adversely affect health and well-being of dolphins. Our present study of behavior and social interactions of SWD dolphins comprises one component of the NMFS evaluation. The study employs quantitative behavioral research techniques, used widely in research on terrestrial animals and adapted from extensive research on bottlenose dolphin behavior at Brookfield Zoo. These techniques include focal-animal sampling, resulting in unbiased coverage of all SWD dolphins; instantaneous sampling, resulting in proportion of time spent in specified behavioral states; and all-occurrence sampling, resulting in rates of specified social interactions. These techniques provide comparable data from each SWD facility, permitting comparison of human-dolphin interactions by facility, by Swim program type, and by dolphin age/sex class, and also permitting comparison of dolphin behavioral profiles during Swims vs. free time. We present the study design, research methods, and kinds of information to be generated, and we advance these systematic observational techniques for broader use in comparing cetacean behavior across different social, ecological, or management conditions.

FISH AND CEPHALOPOD PREY OF SMALL CETACEANS FROM THE SCOTTISH COAST

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Stomach contents of 27 small cetaceans, 15 *Phocoena phocoena*, 4 *Stenella coeruleoalba*, 4 *Lagenorhynchus albirostris*, 1 *Delphinus delphis*, 1 *Grampus griseus*, 1 *Mesoplodon bidens* and 1 *Balaenoptera acutorostrata* from strandings and by-catches in Scotland (1992-1993) were examined to identify prey remains.

A total of 4806 otoliths and 549 upper and lower cephalopod beaks was collected. Thirteen species of fish belonging to 6 families were present: 52.5% of otoliths were of Gadidae, 45.6% Ammodytidae, and the remainder Clupeidae, Carangidae, Merluccidae and Pleuronectidae (all <1%). The cephalopod beaks belonged to 4 species of 3 families, Loliginidae (58.6%), Octopodidae (39%) and Sepiolidae (0.3%).

In *Phocoena phocoena*, *Ammodytes* sp. and Gadidae were the main food items. The loliginids *Loligo forbesi* and *Alloteuthis subulata* were also eaten. In *Stenella coeruleoalba*, cephalopods had a more important role in the diet, with half of the stomachs containing only cephalopod remains. *Lagenorhynchus albirostris* ate mainly fish, particularly *Merlangius merlangus*, also the octopus *Eledone cirrhosa*. Of the remaining cetaceans, *Delphinus delphis*, *Mesoplodon bidens* and *Balaenoptera acutorostrata* stomachs contained mainly fish remains, mostly *Merlangius merlangus* and *Ammodytes* spp., while *Grampus griseus* had only cephalopod remains in the stomach, primarily *Eledone cirrhosa*.

The range of cephalopod species eaten is consistent with feeding in Continental shelf waters. Results are compared with data on diets of small cetaceans off the Galician (NW Spain) coast. In both cases, Gadidae are the most important fish prey but a wider range of cephalopods was present in the Galician samples, including a range of oceanic species absent from Scottish samples.

INDIVIDUAL RECOGNITION IN FREE-RANGING BOTTLENOSE DOLPHINS: A FIELD TEST USING PLAYBACK EXPERIMENTS

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Bottlenose dolphins, *Tursiops truncatus*, produce individually distinctive vocalizations called signature whistles. In order to determine whether signature whistles are used for individual recognition, playback experiments were conducted with wild dolphins at a study site near Sarasota, Florida from 1989 to 1993. A long-term study of these dolphins includes a temporary capture and release program, which provides opportunities to collect information regarding age, sex, and genetic relationships among individuals, as well as to record vocalizations of known individuals. Playback experiments conducted during capture-release sessions consisted of paired trials; in each trial the same two whistle sequences were played back to two different target animals. A sample size of nine paired trials proved to be statistically significant, demonstrating that dolphins were able to discriminate between signature whistles of different familiar individuals. When these results are viewed in the context of what is known about dolphin societies, which are characterized by stable individual associations intermixed with fluid patterns of association among many individuals, it appears highly likely that dolphins use signature whistles to recognize one another as individuals.

INBREEDING ASSESSMENT OF WESTERN NORTH ATLANTIC RIGHT WHALES (*EUBALAENA GLACIALIS*) USING DNA FINGERPRINT AND BEHAVIORAL DATA

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We investigated the hypothesis that inbreeding depression is influencing the recovery of the North Atlantic (N.A.) right whale. The level of genetic similarity among unrelated N.A. right whales was compared to that of unrelated South Atlantic right whales (*E. australis*), a closely related species which was decimated less severely and which appears to be recovering successfully.

DNA fingerprint data indicate that there is less genetic variation among unrelated N.A. right whales than among unrelated S.A. animals (J33.15/HaeIII; $\bar{x}_{U(NA)}$=0.47 0.13 and $\bar{x}_{U(SA)}$=0.29 0.10, p<0.05). In addition, $\bar{x}$ values for N.A. 1° and 2° relatives were lower than predicted from $\bar{x}_{U(NA)}$ (1°: 0.65 vs 0.74, p<0.05; 2°: 0.57 vs 0.60, 0.05<p<0.10). This shift suggests that the matings between closely-related animals (which would have resulted in the high bandsharing coefficients that are missing) were either avoided or unsuccessful. Since right whales are nonsocial, promiscuous animals it is unlikely that they are able to recognise their kin. Consequently, the results provide support for the hypothesis that N.A. right whales are suffering from inbreeding depression. Additional support is provided by behavioral data which suggest that, compared to the S.A. right whales, the North Atlantic right whales are suffering from reduced fertility, fecundity, and increased juvenile mortality.

NEAR-SHORE DISTRIBUTION PATTERNS OF HUMPBACK WHALES IN HAWAII SIMULTANEOUSLY DETERMINED BY THEODOLITE AND SMALL BOAT SURVEYS

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Previous theodolite studies of whales off the Kona coast of the island of Hawaii have shown humpback whale distribution patterns to be a function of distance from shore. However, such studies are confounded by the fact that sightability is also a function of distance. The present study included both theodolite observations from an elevated shore station, and systematic small boat surveys along randomly selected, pre-determined transects run perpendicular to depth contours.

During February and March, 1993, 494 pods of whales (with an estimated 874 whales) were observed during 48.7 hours of effort using a theodolite atop a 30m building 7m back from the shoreline. During 15.8 hours of survey from small outboard-driven boats during the same period, 46 pods (with an estimated 82 animals) were observed. The depth at which each pod was sighted was recorded. Depths were separated into three categories: <30 fathoms, 30-50 fathoms, and 50-100 fathoms.

Both the theodolite data (X^2=88.32, df=2, p<.05) and the boat data (X^2=9.42, df=2, p<.05) showed a significant effect of depth. Subsequent analysis showed that in both cases, frequency of observation decreased significantly with increasing depth. The consistency of these findings suggests that previous theodolite results are not an artifact of decreasing visibility.

STATISTICAL CLASSIFICATION OF DIVING BEHAVIOR: QUANTITATIVE ANALYSES OF WEDDELL SEAL DIVING

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Most recent studies of pinniped diving behavior have subjectively grouped dives according to similarities in the depth, duration, and appearance of the dive profile. Utilizing depth data collected by TDRs attached to Weddell seals, dives were classified using multivariate statistics. Depth values were interpolated so that each dive was represented by an equal number of values. Principal component analysis and cluster analysis were used to determine the categories, and discriminant function analysis was used to test the validity of the categories. These quantitative categorizations were compared to subjective methods to further test their validity. Previous categorizations for Weddell seals and other pinnipeds were also compared with this quantitative method, as were other classification methods. Subjective classification with the aid of error rates produced by discriminant function analysis was conducted to provide an intermediate between completely subjective and objective analyses. Finally, a pattern recognition protocol was created that compared dives to simple geometric shapes. Statistical analyses of behavior may be useful in expediting the analysis of large data sets, providing "on board" classification where data compression is necessary (i.e. satellite transmissions), and reducing human subjective bias in interpreting diving behavior.

TROPHIC DYNAMICS OF MARINE MAMMALS IN ALASKAN WATERS - STABLE ISOTOPE EVIDENCE

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Stable isotope ratios of carbon and nitrogen offer both geographic and trophic information on the marine mammals of subarctic waters. The pronounced latitudinal gradients in carbon isotope ratios in the marine waters surrounding Alaska can be used to assign habitat dependencies and sources of food where migration pathways cross isotopic gradients. Nitrogen isotope ratios increase by 3.0 - 3.5 ‰ with each trophic step but do not vary geographically. The $\delta^{15}N$ values were used to determine relative trophic status of pinnipeds and other marine mammals. Polar bears, as expected, occupy the top trophic position with spotted seals a full level below along with sea lions and bearded seals. Isotope ratios along the lengths of sea lion vibrissae show marked ocillations in $\delta^{15}N$ which are presumed annual based upon similar oscillations in whale baleen. Relatively constant $\delta^{13}C$ values indicate little geographic variation in the isotope ratios of sea lion prey over the region inhabitated. Large variations in $\delta^{15}N$ suggest marked differences in prey selection by individual sea lions over time spans of up to four years. Walrus are considerably lower in trophic status and about one trophic level above the herbivorous benthos upon which they depend, with a slight increase occurring while in the northern section of their range in the Chukchi Sea.. Bowhead whales rank below sea lions and spotted seals but above walrus and are similar in trophic status to arctic cod, a likely competitor for the same food resources. Chronological changes in $\delta^{15}N$ values in bowhead whale baleen reveal a trophic shift in winter months to food enriched equivalent to a full trophic level above summer diet. The source of this enrichment is unkown. Possible prey causing the shift might include juvenile pollock (*Theragra chalcogramma*) or sand lance (*Ammodytes* spp.) but no data are available regarding the winter feeding of these whales.

CONTEMPORARY MANAGEMENT PROGRAMS FOR POLAR BEARS IN ALASKA AND RELATION TO INTERNATIONAL TREATY AND DOMESTIC LAW

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Terms of the Marine Mammal Protection Act of 1972 provide the framework for management programs directed by the U.S. Fish and Wildlife Service. The MMPA was thought to implement all terms of the International Agreement on the Conservation of Polar Bears at ratification, although now it is apparent that aspects to protect habitat, regulate methods and means of harvest, and to provide special protection to females with cubs and their cubs were overlooked. Amendments to the MMPA in 1988 stimulated the development of a Management Plan for Polar Bears in Alaska by the FWS. The Plan is comprised of two major components; a conservation plan, and an implementation plan. The conservation component maps out specific tasks to accomplish four primary objectives: 1) conserve polar bears; 2) conserve polar bear habitat; 3) provide for authorized uses of polar bears including Native subsistence harvest, scientific research, public display and incidental take; and 4) coordinate conservation and management programs at the local, national, and international levels. The Plan is subject to change as a result of annual review by the advisory team, new findings, changes in species status, completion of tasks, Congressional direction, policy changes or legal interpretations.

Much of the implementation plan relies upon development of cooperative management agreements between hunter organizations. These agreements will be broadly supported through development of grants and augmented with a wider public information program.

SOUND PRODUCTION AND BEHAVIOUR OF DELPHINIDS IN SOUTH-EAST QUEENSLAND WATERS

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The underwater sound production of three delphinid species: inshore bottlenose dolphins *Tursiops truncatus*, Indo-Pacific humpback dolphins *Sousa chinensis*, and common dolphins *Delphinus delphis*, was recorded in south east Queensland waters in 1991 and 1992. A Sony TCD-D10 PRO digital tape recorder, custom pre-amplifier and Brüel and Kjær 8105 hydrophone were used to record underwater sounds and verbal descriptions of concurrent behaviours.

The rate of production of sound types implicated in direct communication, namely: whistles, burst-pulses and (newly discovered) low frequency (< 2 kHz) narrowband sounds; varied significantly between behavioural contexts in bottlenose dolphins. The trend of increased sound production in social contexts was observed in humpback and common dolphins also.

The discovery of low frequency (< 2 Khz) narrowband sounds associated with social activity in bottlenose dolphins demonstrated the importance of recording species involved in a variety of behavioural contexts in order to investigate repertoires thoroughly. The absence of these low frequency sounds in almost all studies of bottlenose dolphins may be due to insufficient sampling, bandwidth limitations of equipment or regional differences in sound production.

LONG-TERM MEMORY FOR EQUIVALENCE RELATIONS IN A CALIFORNIA SEA LION

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A california sea lion (Zalophus californianus) was trained to relate nonidentical visual stimuli (arbitrary matching-to-sample). Subsequent tests demonstrated that solely by virtue of having been trained two unidirectional relations (A goes with B, and B goes with C), the animal formed thirty three-member (A, B, and C) classes of stimuli, a phenomenon referred to as stimulus equivalence. Following a nine month interval during which the subject was not tested, she was presented with several combinations of matching trials from the various equivalence classes. Performance on the forward, originally trained relations exceded performance on "reversed" equivalence relations; however, certain classes were remembered virtually without error on all possible trial types. The results confirm earlier studies on long-term memory in California sea lions, and shed light on a non-human's ability to remember and apply language-like conceptual processes.

NORTHERN RANGE LIMITS OF PACIFIC COAST BOTTLENOSE DOLPHINS (Tursiops truncatus) IN CALIFORNIA.

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Sixty-six boat based photo-identification surveys, conducted between October 1990 and December 1992 in Monterey Bay, California, identified 45 naturally marked bottlenose dolphins. Photographs of these Monterey Bay dolphins were compared to a catalog of 426 individuals identified during 241 surveys conducted between September 1981 and December 1989 in four Southern California Bight study areas: Santa Barbara, San Diego, Orange County and Ensenada, Baja, Mexico. Twenty-eight (62%) of the dolphins identified in Monterey Bay had previously been photographed in at least one of the Southern California Bight study areas. Nine of these 28 dolphins were first photographed in Monterey Bay in 1990 and then continuously throughout 1991 and 1992 (Feinholz, 1993) suggesting a degree of site fidelity not previously documented for Pacific coast bottlenose dolphins. These data represent an important replication and extension of previous reports of Southern California Bight bottlenose dolphins photographed in Monterey Bay (Defran et al., 1991; Wells et al., 1990). Together these reports suggest that the northern range limits for at least 6 % (28/426) of the Southern California Bight population of bottlenose dolphins extends as far as central California.

RADIOTRACKING OF SPOTTED DOLPHINS ASSOCIATED WITH TUNA IN THE EASTERN TROPICAL PACIFIC

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As part of a study of the tuna-dolphin bond, six spotted dolphins were radiotracked in the eastern Pacific Ocean during November 1992. The dolphins were tracked over a period of a week, providing data on their movements, surfacing times, and dive profiles. They travelled both day and night, covering about 60 miles/day. Three dolphins also carried Time-Depth Recorders (TDRs) and two TDRs were recovered when the dolphins were recaptured after 1-2 days at liberty. The TDR data showed distinct day-night differences in diving patterns. The spotted dolphins swam within the mixed layer during the daytime, often at a depth of 10-20 m, but dove well below the thermocline at night. At dawn and dusk, both dolphins appeared to feed at depth, making dives to 50-100 m that lasted up to 4.7 min. long. Their diving patterns suggested that the dolphins were feeding at night on organisms associated with the deep scattering layer. Repetitive sets on the same dolphins also allowed us to examine the short-term herd integrity and the association with yellowfin tuna.

MANAGEMENT PROGRAMS AND PLANNING FOR THE PACIFIC WALRUS

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Amendments to the Marine Mammal Protection Act in 1988 stimulated a long range planning process for management of the Pacific walrus (Odobenus rosmarus divergens). The USFWS is preparing a Management Plan (current version is a "Draft Final") comprised of 2 parts: (1) A Conservation Plan that provides an overview of species biology, conservation issues, and tasks intended to accomplish management objectives. Objectives include: monitor population status and trends; define the optimum sustainable population (OSP) range; identify, protect, and monitor essential habitat of the Pacific walrus; identify, monitor, and manage human activities affecting walrus; ensure harvest by Native Alaskans will allow the population to remain within its OSP range; establish information and education programs; and coordinate cooperative conservation efforts. (2) An Implementation Plan that prioritizes tasks, provides a schedule for accomplishing tasks, and estimates costs.

The Plan identifies alternative management strategies, some of which would require amendments to the MMPA. As reauthorization is in process and final selection of some management strategies is linked to proposed amendments, the Plan may not be finalized until the MMPA is reauthorized. An update and review of the Final Plan and programs to be implemented within the next 1-2 yr will be provided.

Implementation will depend on development of cooperative agreements with Native hunters and adequate funding.

STABLE ISOTOPE STUDIES OF STELLER SEA LIONS AND OTHER ALASKA PINNIPEDS

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Analysis of stable isotope ratios in Steller sea lion (*Eumetopias jubatus*) tissues offers a tool for investigating trophic relationships and other aspects of diet. $^{15}N:^{14}N$ and $^{13}C:^{12}C$ typically are greater at higher trophic levels, allowing comparisons among different species within an ecosystem or among age and sex classes of particular species. This work will examine isotope ratios in skeletal muscle, bone collagen, hair, claws, vibrissae, skin, and blubber. Each tissue type holds a different dietary record depending on its turnover time. Other analyses include comparison of trophic relationships for 1) age- or sex-specific differences in Steller sea lions; 2) historical differences in Steller sea lions from the 1950s to the present; and 3) differences between Steller sea lions and other pinnipeds in Alaska. Analyzed tissues will include skeletal muscle, hair, claws, vibrissae, skin, and blubber from Steller sea lions, harbor seals (*Phoca vitulina*), and northern fur seals (*Callorhinus ursinus*). This work is part of a trophic investigation of the Gulf of Alaska that also includes samples of zooplankton, fish, and seabirds. An isotopic food web model will allow trophic placement of individual species. Cooperating agencies include U.S. Fish and Wildlife Service and the Canadian Wildlife Service.

PROGRESS ON THE KNOWLEDGE OF CETACEANS IN SOUTHERN BRAZIL.

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Since 1987, surveys along the 400km of the southern portion of the Rio Grande do Sul State (RS) coast (29°19'S - 33°45'S), interviews with fishermen and nine cruises onboard longline fishing vessels have been carried out in order to obtain information on the general ecology of cetaceans in south Brazilian waters. In October 1988, an adult female Bryde's whale, Balaenoptera edeni, was found dead in the mouth of the Patos Lagoon estuary and in 1990, a mandible found on the beach was identified as belonging to a Cuvier's beaked whale, Ziphius cavirostris. Both represent first records for the RS coast. In April 1992, a 23.12m female blue whale, B. musculus, was recorded in Chui Beach, being the first stranding of this species in Brazil and the second in the Southwest Atlantic. In February 1993, a 4.29m female Blainvillei's beaked whale, Mesoplodon densirostris, was found washed ashore in Mar Grosso Beach. This is the second record of the species for the Southwest Atlantic. In November 1992, a 3.43m male dwarf minke whale, B. acuturostrata, was accidentally caught off RS (33°35'S, 51°29'W). This specimen had been feeding on Euphausia similis, for the first time recorded as a food item for minke whales. In 1990, a recently dead short finned pilot whale, Globicephala macrorhynchus, was seen drifting in deep waters at 23°50'S and, in August 1991, a herd of about 30 spinner dolphins, Stenella longirostris, was sighted at 25°35'S. Both were the southernmost confirmed records of these species in the Southwest Atlantic. Killer whales, Orcinus orca, were originally reported predating on swordfish, Xiphias gladius, caught in longlines, sometimes causing daily losses of about 50%.

Although the monitoring efforts have increased in the last 15 years, this study highlights the necessity of creating a cetacean sighting and stranding network with the purpose of gathering standardized data, which remains scarce in the Southwest Atlantic.

ARE UNEXPECTEDLY HIGH LEVELS OF PCBS AND OTHER ORGANOCHLORINES IN WALRUS DUE TO PREDATION ON SEALS?

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Walrus blubber from Inukjuak and Akulivik (E. Hudson Bay), Foxe Basin (Igloolik) and Loks Land (E. Baffin Is.) was analysed for PCB congeners and other persistent organochlorines (DDT, toxaphene, chlordanes, dieldrin, mirex) as part of studies documenting spatial trends in contaminants in Canadian arctic marine biota. Samples from 17 of 58 individuals had concentrations of ΣPCBs ranging from 1 to 20 $\mu g/g$; the remaining individuals had much lower concentrations (0.05-0.6 $\mu g/g$). Highest concentrations were found in samples from Inukjuak where 12 of 14 animals (males and females) had high levels. ΣPCB concentrations greater than 0.5 $\mu g/g$ were unexpected based on previous studies in Greenland and Alaska. Local contamination was ruled out because DDT, chlordanes and toxaphene were elevated in the same animals, and elevated levels were found in both males and females from 3 of 5 locations. ^{13}C and ^{15}N isotope measurements using muscle samples from the jaws of walrus and seals, showed that walrus with high ΣPCB had higher $\delta^{15}N$ values than those with low PCBs. The results suggest that the walrus with elevated organochlorines are feeding at a higher trophic level than those with low levels and are probably utilizing ringed seals for a significant proportion of their diet.

ICE ENTRAPMENTS OF BLUE WHALES (BALAENOPTERA MUSCULUS) ON THE SOUTHWEST COAST OF NEWFOUNDLAND

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Ice entrapments of blue whales on the southwest coast of Newfoundland have been reported on a regular basis since 1974, specifically in two regions: Port-aux-Basques and Port au Port. Prior to 1974, ice entrapments of blue whales were rarely observed or reported. From 1974 - 1992, at least 35 animals have been trapped in pack ice, of which 22 (62.8%) have died.

Blue whale surveys were conducted on the S.W. coast between 1987-1992. Historical records were studied to assess conditions and population distributions prior to this period.

Early newspapers and journals showed no records of ice -entrapped blue whales, whereas modern media did. Comparison of historical and modern ice data showed no significant difference in number of ice days or number of ice entrapment opportunities for the Port-aux-Basques region. However, there were significantly more ice days and number of ice entrapment opportunities in the modern era when compared to the historical period for the Port au Port region. Comparison of historical catch rates and sighting rates from modern surveys suggest that more blue whales were sighted in the modern era than during the whaling era. Two hypotheses are discussed to explain the apparent increase in blue whale ice entrapments.

OBSERVATIONS OF RISSO'S DOLPHINS (GRAMPUS GRISEUS) WITH GRAY WHALES (ESCHRICHTIUS ROBUSTUS)

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There are no previously published accounts of Risso's dolphins associating with gray whales, though there have been documented observations of these dolphins interacting with a variety of other cetaceans. We have knowledge of seven encounters between Risso's dolphins and gray whales in the waters off Monterey, California, within the last 12 years. Increases in the abundance of both Risso's dolphins and gray whales in this area within the last 20 years may explain why sightings have only occurred since 1981. During the interactions, Risso's dolphins demonstrated behaviors ranging from apparent aggression to play. The gray whales appeared agitated and often assumed defensive postures. During six of the sightings, the dolphins encircled the gray whales who reacted by stopping and lying at the surface ventral side up. In two instances, whales changed direction and rapidly swam away toward shore. One whale continued to nearshore kelp beds and into the surf line. These behaviors have also been observed when killer whales (Orcinus orca) are present. Risso's dolphins appear to be highly energetic in their associations with their own kind and other small cetaceans and demonstrate a strong herding instinct. It may be that the dolphins' normal intra- and inter-specific behavior appeared threatening to the gray whales. The Monterey and Carmel Canyons are the only areas where the Risso's dolphins' affinity for very deep water overlaps with the gray whales' migration along the coast; therefore, these interactions may be a localized phenomenon.

A COMPARISON OF PREY SPECIES AND PREY SIZE BETWEEN MALE AND FEMALE/IMMATURE STRAP–TOOTHED WHALES *Mesoplodon layardii*

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The food habits of strap–toothed whales were examined in detail using stomach contents of 12 stranded whales (4 mature males, 1 immature male and 7 females). Although a few unidentified fish otoliths and crustaceans were found in these stomachs, 93.3 % of counted prey items (n=128) were 14 species of oceanic squids and some of these occur at a great depth. The predominant prey species were *Histioteuthis* sp. and *Taonius pavo* (48.7 and 16.8 % by number, 41.3 and 20.9 % by weight, 63.6 and 45.5 % by frequency of occurrence respectively). Prey sizes were compared between males with fully grown strap–teeth and females/immature male without erupted teeth, using dorsal mantle lengths (DML) and weights of squids estimated from beak measurements. There was no significant difference both in DML (two sample t test; $t = 0.379$, $P = 0.705$) and in weight ($t = 0.739$, $P = 0.461$) between two groups. The presence of fully–erupted teeth in adult males, therefore, did not seem to influence the size of prey ingested, even though a adult male could only open his jaws to a maximum of 3.2 cm (at the tip), compared to 6.5 cm for a female.

LABORATORY TESTS OF HUMPBACK WHALE PREDATION ON SCHOOLING FISH: THE EFFECTS OF BUBBLES, BLAZE FEEDING, AND BIOACOUSTICS.

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Humpback whales (Megaptera novaeangliae) are known to engage in unusual feeding behaviors including the use of bubbles, feeding calls, and thrusting of their appendages at prey. This study tests the response of prey to simulated humpback whale predation in the laboratory environment. Schools of 50 Pacific herring (Clupea harengus pallasi) were exposed to bubble structures, an artificial pectoral fin, and playback of humpback whale feeding calls. The fish schools exhibited a strong flight response to bubbles and rarely swam through bubble nets or curtains even when frightened with percussive sounds or an approaching object. The fish also responded negatively to playbacks of feeding calls (increased speed, loss of school cohesion) suggesting a prey-manipulation function of the calls. The herring schools also consistently took flight from a rotated pectoral fin along a trajectory that ran perpendicular to the long axis of the fin; an indication that whales may be readily able to control the movements of schooling prey by adjusting the angle of their appendages.

FIELD OBSERVATION OF BOTTLENOSE DOLPHINS IN OGASAWARA, JAPAN.

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Since the late 80's, wild bottlenose dolphins (*Tursiops truncatus*) have been known to approach divers around the Ogasawara Islands. A research program to study social structure, life history and behavior of these dolphins started in August 1992, and is still in progress.

Individuals have been identified by birthmarks, scars and nicks on their bodies and fins, on the images recorded with underwater videocameras. Sex has been determined by underwater observations of a genital area. Dolphins have been classified into one of the following four age classes by the body size and the density of spots on the belly : [1] calf and juvenile (smaller size and no spots), [2] subadult (full size and no spots), [3] younger adult (full size and low density of spots) and [4] older adult (full size and high density of spots).

Over 100 individuals have been identified. Some of the dolphins were resighted repeatedly during this research. Several dolphins in photographs and videotapes taken by local divers a few years ago were also sighted. These results indicate that at least some dolphins are resident in the study area. Size and members of the herds were variable.

LIPID STRATIFICATION AND CONTAMINANT DISTRIBUTION IN THE BLUBBER OF BOTTLENOSE DOLPHINS

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Dorsal blubber cores from bottlenose dolphins (*Tursiops truncatus*), collected by the Texas Marine Mammal Stranding Network, were divided into three sections based on macroscopic structure to investigate differences in lipid content and contaminant concentrations. Polychlorinated biphenyls (PCBs) and chlorinated pesticides were determined in each section by gas chromatography with electron capture detector.

Bottlenose dolphin blubber was found to be heterogeneous tissue containing 14.6-75.1% lipid. The middle section generally contained the highest percentage of lipids. In males, lipid content of the outermost section was relatively constant. The outermost section in females and the inner section for both sexes were more variable.

Total PCBs ranged from 4,760-46,113 ng/g (dry weight) for females and 58,520-110,577 ng/g for males. Total DDT ranged from 1,637-19,035 ng/g for females and 14,477-61,512 ng/g for males. Apparent differences between the sections did not yield consistent contaminant patterns; however, when data were normalized to lipid content, few between-section differences remained. Data for one male and one female still displayed significant between-section differences after normalization.

This study suggests that subsampling bottlenose dolphin blubber cores for PCB and pesticide analysis will yield data that are representative of the entire core, if the data are calculated on a lipid basis. Accurate representation is significant for analysis of biopsies, which are necessarily subsamples of the blubber core.

MITOCHONDRIAL GENETIC VARIATION IN THE NORTH ATLANTIC LONG-FINNED PILOT WHALE POPULATION AND ITS RELATIONSHIP TO SOCIAL BEHAVIOR

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The long-finned pilot whale (*Globicephala melas*) inhabits temperate and subpolar waters throughout the North Atlantic. Pilot whales are incidentally taken by commercial fisheries operating in US waters, and are or have been hunted in parts of their range. Additional mortalities occur during mass strandings. Although these losses are presumably small compared to the size of the entire North Atlantic population, isolated subpopulations could potentially be affected by local mortalities. In order to determine if there is more than one genetically distinct population within the North Atlantic, I sequenced a 400-bp region at the 5'-end of the mitochondrial D-loop from 59 long-finned pilot whales that stranded on western and eastern North Atlantic coasts or were incidentally caught by commercial fisheries operating in the western mid- North Atlantic. Samples from 11 Atlantic and 2 Pacific short-finned pilot whales (*G. macrorhynchus*) were also analyzed. Surprisingly, I found that North Atlantic long-finned pilot whales have extremely low levels of D-loop sequence variation; the sequences determined for fifty-five whales from the eastern coast of the United States and Great Britain were identical. Because this pilot whale population has not passed through a severe population bottleneck, I have speculated that this low level of mitochondrial genetic variation may be due to metapopulation dynamics resulting from the social system of pilot whales. Preliminary results from computer simulations and a review of mitochondrial genetic variation found in other cetacean species support this hypothesis.

NOTES ON BEHAVIOUR OF LAKE LADOGA RINGED SEAL (Phoca hispida lagodensis).

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Lake Ladoga with it's area of 18.400 km^2 is the largest lake in Europe. The mean depth of the lake is 51 meters and the number of islands is only 660. The population size of ringed seal in Lake Ladoga is unknown. In 1991 a research project was started in the northern part of the lake. The aim of the study is to determine the population status and to make a conservation plan for the seal.

The lairs of the seals are mostly found on ridged ice of open shore, but some are built in snowdrifts on the shorelines of islands. In summer, herds of up to 50 seals are found in the Valamo archipelago. While laying on rock, the seals communicate acoustically with each other, e.g. by using two kinds of warning signals called "splash" and "mmock".

The lairing behaviour resembles that of Saimaa ringed seal (P.h. saimensis) living in small and labyrinthine lake basins and in Lake Ladoga is thought to indicate undisturbed environment and lack of predation. The tendency for herding is risky in areas where strong fishing nets are used. The shoreline lairing and herding behaviour will probably disappeared, with the economic development which will strongly increase professional fishing and man made disturbance in Lake Ladoga.

REVIEW OF THE DISTRIBUTION OF SMALL CETACEANS OFF BRAZIL

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The available information on the occurrence of small cetaceans in Brazilian marine waters was reviewed. The data gathered from 1984 to 1993 through sigthings, strandings and port monitoring are included. Twenty-four species of small cetaceans, belonging to five families, are presently known to occur within the 200 nautical miles limit of Brazilian marine waters. Atlantic spotted, spinner, rough-toothed, common, and bottlenose dolphins are found in coastal waters, apparently using the same habitat of tucuxis and franciscanas. Some species are still very poorly known for the paucity of records of sightings and/or strandings. These include, at least, Risso's dolphins, pygmy and dwarf sperm whales and beaked whales. Burmeister's porpoise and Blainville's, Gray's and probably strap-toothed beaked whales have been found in southern Brazil as result of the influence of subantarctic cold waters. The two pilot whale species seem to have an overlap in distribution off southeastern Brazil. Tropical and subtropical waters are able to support a rich and diverse cetacean fauna.

INTERACTION OF CETACEANS WITH FISHERIES ON THE MEDITERRANEAN COAST OF SOUTHERN SPAIN

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From April to August, 1992, a survey of interactions between cetaceans and fisheries was carried out in the Alboran Sea, an area with high concentration of cetaceans, particularly the common dolphin (Delphinus delphis). The fishing fleet in that area is composed of a total of 1,651 boats (273 trawlers, 243 purse-seiners, 176 longliners, 972 artisanal fishing boats, and 25 driftneters). These latter, although illegal, are still operative. 102 fishermen from 20 harbours were interviewed and three observers were placed in drifnet boats for seven days to collect information on incidental catches. Results showed that purse seiners and drifnets are the most conflicting operations in the area in this respect, the latter producing up to 50 to 75 cetacean kills per boat/year. Moreover, direct catches of dolphins for use as bait for shrimp traps are also known to occur in the area.

MOVEMENTS, DIVING AND HAULOUT BEHAVIOR OF A GREY SEAL (*Halichoerus grypus*) IN THE BALTIC.

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The population of grey seals in the Baltic was estimated to be nearly 100,000 animals in 1900; by the 1970s, it was as low as 1-2000, a result of extensive hunting and, later, reduced reproduction caused by PCB contamination. While the period of intensive hunting and study of contaminants produced a wealth of anecdotal information on movements and foraging habits, little has been done to study these subjects directly. We report here the initial phase of a study implemented to address this lack of knowledge in order to allow effective management of the current growing population.

We glued an Argos satellite-linked data logger to a sub-adult male captured (Lat.61'28'00 Lon.17'25'40) in the archipelago of Hudiksvall, Sweden. During 116 days, it transmitted 841 positions, data on the depth and swim speed of 3564 dives and identified 80 haulout periods.

Swimming and diving activity was divided into 4 distinct phases; 2 phases of local movements around a haulout area, separated by 2 phases of longer distance movements (660 km in12 days, 550 km in 8 days). The animal ranged more widely then expected. Analysis of the dive records showed a maximum dive depth of 124 m, average max. dive depth of only 25.7 m. An velocity index was measured for 5 equal long phases in each dive. After compensation for non-actively dives the phases had an average of 1.12, 0.99, 0.98, 1.10 and 1.35, The longest dive was 22 min. Most dives seemed to reach near to the bottom, suggesting benthic foraging. Other features of the diving behaviour showed a diurnal change; the fraction of time spent diving was greater during the day while the time spent at the surface increased at night. Generally the haulout periods occured during dusk, night and dawn.

CONTEMPORARY LEGENDS ABOUT INIA GEOFFRENSIS: POSSIBLE BASES IN PHYSICAL AND CULTURAL FACT

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This paper offers a summary of some of the most common legends about the Amazonian freshwater dolphin, Inia geoffrensis, or boto. Each legend is followed by a short discussion of possible bases in both Amazonian cultural realities and in physical fact. For instance, many people claim that botos are malevolent beings who seek to drown the occupants of small canoes. These claims may well be linked to indigenous beliefs about powerful and dangerous Aquatic Seducers as well as to Inia's extreme curiosity and penchant for physical contact that might lead to the inadvertent capsizing of a fragile craft. The paper is based on extensive on-site fieldwork in the Brazilian Amazon and elaborates on a number of the findings to be discussed in Dance of the Dolphin (University of Chicago Press, 1994.)

MOVEMENTS AND DIVING BEHAVIOUR OF SOUTHERN ELEPHANT SEALS FROM HEARD ISLAND.

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The movements and diving patterns of 13 adult female and five adult male southern elephant seals from Heard Island were monitored using microprocessor controlled geolocating time-depth recorders. The instruments were glued to the backs of seals at the end of the moult from February to April, 1992, and also on females at the end of the breeding season in November, 1992. Males foraged over winter deep within the pack ice, mainly along the Antarctic continental shelf where water depths are between 500 and 1,000 metres, from the Gunnerus Bank in the west to the Shackleton Ice Shelf in the east. Females also foraged over winter in Antarctic waters, generally further north than males, and ranged west to the Southwest Indian Ridge and the Riiser-Larsen Sea, and east to an area north of the Shackleton Ice Shelf. Following the breeding season females foraged over summer generally in the area of the Kerguelen Plateau, ranging east as far as the Southeast Indian Ridge. Seals dived continuously while at sea. Mean dive depth for individuals ranged from 224 to 557 m (maximum depth 1502 m) for males and from 202 to 468 m (maximum depth 1496 m) for females. This study demonstrates the importance of Antarctic waters as foraging grounds for the Heard Island southern elephant seal population.

HUSBANDRY AND MEDICAL RECOMMENDATIONS FOR CAPTIVE REARING OF STELLER SEA LION (EUMETOPIAS JUBATUS) NEONATES

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The recent, precipitous decline in the Steller sea lion (Eumetopias jubatus) population has led marine mammal rehabilitation personnel to examine foster care techniques for possible application as part of the recovery plan for this species. The Marine Mammal Center has rehabilitated seven neonatal Steller sea lions since 1981. Four pups survived to release, after rehabilitation periods of nine to 12 months. Weight increased from a mean of 20 kg on admission to 70 kg at release. One animal was dead on arrival. Post mortem findings for all nonsurvivors include starvation and verminous pneumonia in one animal, hepatitis,pleuritis, and nephritis for the second, and cerebellar herniation secondary to brain edema for the third.

Surviving animals were released based on behavioral and physiological criteria. Long term post release survival is not known, however one animal was visually sighted two weeks after release near the release sight.

Work done at marine mammal rehabilitation facilities may aid in the recovery of the Steller sea lion as husbandry techniques, laboratory analyses, and overall assessment protocols developed for California sea lions (Zalophus californianus), and modified for Steller sea lions, are refined in a controlled environment.

RIGHT WHALES AND DREDGING IN THE SOUTHEAST US: ONE APPROACH TO CONSERVATION MANAGEMENT

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Along the coast of the southeastern United States lies the only known calving ground* of the North Atlantic right whale (Eubalaena glacialis), the large whale closest to extinction. Interactions with large vessels in the calving ground present a direct threat to right whales. Mortalities, as well as scarring, from such interactions have been observed with increasing frequency in these waters. Ocean-going hopper dredges used for deepening and maintaining military and commercial shipping channels have significantly increased large vessel traffic in this area during the past six years. Thus the U.S. Army Corps of Engineers, acting on a directive from the National Marine Fisheries Service, has funded daily aerial surveys of waters adjacent to dredging operations during the right whale calving season (December - March). When right whales were sighted within 10 miles of dredging activities, the dredges reduced speed to less than 5 knots during nighttime or limited visibility operation in order to minimize the potential for dredge/whale collisions. During the past 3 years, personnel from the New England Aquarium have flown 197 surveys associated with 235 days of dredging operations at Kings Bay, GA, Brunswick, GA and Savannah, GA. There were eighty sightings of right whales on these surveys. Thirty-six of these sightings were of mother/calf pairs. Dredges reduced speed on 49 nights and though dredges had to alter course to avoid collisions with right whales on several occasions while running full speed during daylight hours, no dredge/whale collisions have been observed. All right whales sighted were photographed and subsequent identified and integrated into the North Atlantic Right Whale Catalog curated by the New England Aquarium.

* This area is currently under review for critical habitat designation by the federal government.

BEHAVIOUR AND SOCIAL ORGANISATION OF HECTOR'S DOLPHIN: TOWARDS BETTER WAYS OF CLASSIFYING BEHAVIOUR

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Associations among Hector's dolphins photographically identified off Banks Peninsula, New Zealand, were studied using cluster analyses of simple and half-weight association indices. In addition, we carried out a temporal analysis of association patterns, plotting changes in the standardised reassociation rate over time. Social organization was characterized by relatively fluid association patterns, with little stability over periods longer than a few days. Male and female Hector's dolphins interacted with a large number of other individuals, males more than females. Association patterns and behavioural data support the hypothesis that Hector's dolphins have a promiscuous mating system, in which males move from group to group searching for sexually active females rather than attempting to monopolize females. Analysis of the temporal relationships among behaviours was used to classify behaviours into five categories: 'feeding', 'sexual', 'aggressive', 'play' and 'aerial'. In this way, I avoided a subjective classification of behaviours into categories based on the observer's impressions. I investigated the relationship between the sexual behaviour category and social context in more detail. The rate of sexual behaviours per individual was highest in groups of 11-15 dolphins, and tended to increase after groups came together. This implied that the definition of 'group' used in this study had meaning to the animals themselves.

A STUDY OF THE GENETIC VARIABILITY OF TWO INSHORE DOLPHIN SPECIES USING mtDNA ANALYSIS AND RAPD FINGERPRINTING.

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Population estimates show a decline in the numbers of bottlenose (*Tursiops truncatus*) and humpback (*Sousa chinensis*) dolphins along the Natal coast, South Africa. The accumulation of chemical pollutants, incidental entrapment in shark nets, shifts in prey abundance as a result of siltation of rivers, as well as natural mortality due to shark attack contribute to a rate of depletion which exceeds the natural replenishment rate of the species.

In order to enforce effective management and conservation of these species, it became necessary to determine the genetic structure of these populations. Analysis of the mtDNA (RFLP and TGGE) suggested a very low degree of variability in the female lineage of both species. Thus, RAPD fingerprinting was used to assess the genetic variability of the two species. By comparing the variability in the mtDNA to the total genomic variability obtained from RAPDs within and between geographically-designated groups, the possibility of roving males as opposed to structured breeding within schools, was investigated.

SUB-SPECIFIC DISCRETENESS OF THE HARBOUR SEAL (*PHOCA VITULINA*)

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Morphological differences among four oceanic and one freshwater sub-species of harbour seals (*Phoca vitulina*) and two closely related species were examined using craniometric analyses. Twenty-nine characters were recorded on 303 crania from harbour seals, spotted seals (*P. largha*), and ringed seals (*P. hispida*). All group means were significantly different from one another ($P < 0.0001$). *A posteriori* classifications based on discriminant scores were high for all groups (ranging from 78 to 98%). Harbour seal crania that were incorrectly classified were most often grouped into the other population from the same ocean. All five harbour seal sub-species were, therefore, morphologically distinguishable, and the groups that were most similar were those predicted by their historical biogeography. These results are currently being compared with those from RFLP analyses of mitochondrial DNA to determine whether the morphological differences are reflected genetically.

FACTORS INFLUENCING THE DISPLAY BEHAVIORS OF HUMPBACK WHALES.

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This study focused on the display behaviors (breaches, lobtails, and flipper slaps) of adult Humpback Whales, *Megaptera novaeangliae*, during summer feeding. Fourteen behavioral and environmental variables were examined including hour of day, slope and depth of the ocean floor, focal animal size, distance to conspecifics and group stability. The majority of displays occurred in early afternoon, immediately prior to in feeding behaviors. Typical bouts consisted of a single display, lasting less than a minute. Displays were shown to be influenced by several factors. Adult humpbacks displayed most often when alone or as part of a trio and increased when conspecifics came within 1/2 mile. Groups became less stable within +/- 15 minutes of a display. The data offer no new evidence to support nonsocial explanations such as stretching or parasite removal for these behaviors. The displays seem to indicate social connotations such as a show of strength or a generalized indicator of excitement. The most significant conclusion is displays are caused by other humpbacks and events outside the group.

BASELINE BEHAVIOR OF HUMPBACK WHALES NEAR KAUAI, HAWAII

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Humpback whales (*Megaptera novaeangliae*) were observed from shore to assess baseline behavior relative to potential effects of low-frequency sounds associated with the Acoustic Thermometry of the Ocean Climate (ATOC) experiment to be conducted January 1994 - June 1995 off northern Kauai. Whales were tracked from the north and south shores of Kauai to obtain baseline data from "experimental" and "control" (acoustic shadow) sites, respectively. Data were collected using theodolites, binoculars, and time-event recorders from 30 January - 16 April 1993. Fifteen-minute scan samples were conducted once every two-hour observation period to assess sighting rates for whales within 4 km of land. Focal samples determined respiration rates, orientation, speed of movement, and surface-active rates by group size, behavioral state, and vessel proximity. A total of 189 focal groups (pods) were followed for a total of 110 hr. Most whales traveled through the area with little change in orientation. Resting at the surface was exhibited primarily by cows with a calf. A stationary behavioral state (little or no forward movement) occurred most frequently among pods of 1 and 2 adults, and pods with a calf. Pods of >2 adults tended to be more surface active than other groups. The peak sighting rate for both the north (2.0 pods or 4.5 whales/scan) and south (1.4 pods or 2.8 whales/scan) shores occurred during March based on 291 scans totaling 73 hr. Thirty-four calf sightings were made. Pods of >2 adults comprised only 15% of all scan sightings and occurred less frequently than reported for the Maui and Penguin Bank regions of Hawaii, suggesting that Kauai is less utilized for aggressive courting activities.

ESTIMATING THE EFFECTS OF SEASON-AREA CONTROLS ON FISHING ON BY-CATCH AND LANDINGS

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Fishermen using demersal gillnets for ground fish in the Gulf of Maine incidentally kill biologically significant numbers of harbor porpoise. There is interest in controlling seasonal and area distribution of the fishing activity to reduce this by-catch, and potentially to reduce the effect of fishing on the target ground fish species. An interactive Geographic Information System procedure called Swan Tracks was developed to integrate several sources of information on the fishery and the harbor porpoise by-catch, including data collected in-port on landings and fishing effort, and that collected at-sea on catch, by-catch, and landings. The goal was to measure the effect of any selected area-temporal closure in terms of reduction in by-catch of harbor porpoise or landings of target species. This procedure was designed to assist the researcher or manager in interactively defining candidate time areas and time periods by allowing simultaneous display of in-port and at-sea data. The procedure was also designed to allow the spatially coarser in-port data to be prorated to the specific fishing locations represented in the at-sea data, thereby allowing immediate evaluation of the amount of by-catch, landings, and fishing trips which occurred in previous years in any arbitrarily shaped geographic area.

WHISTLE PRODUCTION IN BOTTLENOSE DOLPHINS (TURSIOPS SP

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Whistles were recorded from free ranging bottlenose dolphins in Shark Bay, Western Australia over a period of four years. Females and calves conformed to the traditional "signature" whistle model, with each individual producing one whistle type most or all of the time, though sometimes with considerable graded variation in contour structure. The whistles recorded from four provisioned females, three of which are related, were similar, but easily distinguished. Males produced a greater variety of different whistle types and their whistle repertoires changed more over time than females. Several whistles were present in the repertoires of more than one of the three provisioned males. Between 1985 and 1987 these males formed an alliance and began cooperatively herding females. During the same time span the males converged on one whistle type that became the most abundant in the repertoires of all three by 1987. If the most commonly produced whistle is considered a dolphin's "signature" then the three provisioned males can be said to have converged upon a common signature. Convergence of vocal signals among group members occurs in some birds (by a variety of mechanisms) but has not been reported in mammals. Convergence of signature whistles during formation of a cooperative alliance indicates that these vocal signals play an important part in mediating complex social relationships. This may help to explain the unusual abilities of dolphins to imitate and to learn whistles.

EARLY EMBRYOGENESIS OF THE PERIFERAL AUDITORY SYSTEM IN TERRESTRIAL, SEMI-AQUATIC AND AQUATIC MAMMALS

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Using a wide number of species presenting an ecological range from terrestrial to semi-aquatic and aquatic mammals - a comparative study was made of the peripheral auditory system of animals in prenatal ontogegesis. The study was performed using a unique collection of *cetaceans* and *pinnipeds* embryos.

The results of the comparative study have shown that in the representatives of different ecological groups formation of the outer, middle and inner ear structures in early prefetal period proceeds with a similar sequence and roughly at the same developmental stages. The most similarity in the formation of the peripheral auditory system is noted in the first half of early prefetal period. Species specific features of the structural organisation of the auditory organ appear in the second half of early prefetal period, depending on the frequency tuning of the auditory system of the given species. The process of cell differentiation of the Corti's organ and resorbtion of epithelial cells of the auditory meatus in the "precocial" species {*Artyodactyla., Pinnipedia., Cetacea.* and others} is practically completed by the moment of birth. In the "altricial" species {*rats, mice*} differentiation of the elements of the cochleate canal, of the cells of the Corti's organ,and resorbtion of the auditory meatus epithelium is not completed till the 20th day of early postnatal development; in bats it is completed by the 25-30th day {Airapetyants, Konstantinov, 1974}. In these species fetal development is not completed until after birth. In echolocating forms {*bats., dolphins.*}, belonging to different taxonomic and ecological groups, common features in the development of the middle and inner ear appeared through parallel evolution in the course of which conditions were created for intraspecific acoustic communication in the specific environment unfavourable for eyesight.

One of the aims of the comparative embryological study of *cetaceans.* and *pinnipeds.* was to reveal their phylogeny. Our comparative morphological and embryological study of the peripheral auditory system revealed principal differences in its structure between representatives of two suborders of *cetaceans.* {*Mysticeti., Odontoceti.*} and within the order *Pinnipedia.* - between *Otariidae.*, on the one hand, and *Phocidae* and *Odobenidae.*, on the other. The results seemed to favour the hypothesis of diphyletic rather than monophyletic origin of these mammals. However, in the developmental study of the auditory organ it was shown that in the *cetaceans.* and *pinnipeds.* at similar developmental stages in early prenatal period there is a similarity in the structure of the outer and middle ear, whereas in the fetal period it acquires species specific features.

ACOUSTICALLY DETERMINED DISTRIBUTIONS OF SPERM WHALES IN THE NORTHWESTERN GULF OF MEXICO

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Distributions of sperm whales (*Physeter macrocephalus*) in the northwestern Gulf of Mexico were determined from acoustic recordings collected from a towed linear array, with a range of approximately 18 km. This study is part of the GulfCet project; an ongoing project sponsored by Minerals Management Service to determine abundance and distributions of marine mammals in the Gulf of Mexico. The study area consists of 13 north/south transects at 74.1 km intervals. These transects range from the 100 m to 2000 m isobaths from the Florida-Alabama to the Texas-Mexico borders, in the northwestern Gulf of Mexico. During cruises in April, August, and November 1992, and February and May 1993, there were a total of 46 acoustic sperm whale contacts, with a contact defined as an encounter with a single group or aggregation. The average bathymetric depth per contact was 1266 m (sd = 426). Distributions relative to sea surface temperatures, as indicated by sea-surface satellite images are determined. Areas of apparent concentrations occurred in the Mississippi River Canyon and east of the 1000 m isobath, as it curves around the south Texas coast. Sperm whales were recorded in these areas during each cruise.

DISEASES FOUND IN STELLER SEA LIONS FROM THE GULF OF ALASKA AND BERING SEA

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For the last seven years investigations of the causes of death and diseases of free-ranging Steller Sea Lions have been done. Methods of investigation have been necropsy of animals that were either found dead or collected. Procedures performed on animals included gross necropsy, histopathology, bacteriology and serology.

A subacute ulcerative dermatitis with alopecia, acanthosis and keratosis due to calicivirus and lice was found in pups. A chronic active dermatitis due to an unidentified mycotic agent was common. A mild multifocal pneumonia associated with lungworms and secondary bacterial infection was common. Mild mucopurulent rhinitis associated with nasal mites was extremely common. Gastric ulceration due to ascarids and gastric foreign bodies was a common incidental finding. Acanthocephalans and cestodes were found in the small intestine and caecum. Positive serological titers to chlamydia were found. A chlamydial organism was isolated from an aborted fetus from Cape St. Elias, Alaska. Emaciation was found in two 8-10 month old animals. A mild degree of neuronal degeneration was found in the brain stem of two adults. Gun shot was found in two adults.

A variety of diseases and infectious agents were found but none appeared to be related with the general decline. Abortion may be a significant factor in the decline of Steller populations. The causitive agents of abortion have not been determined and further work needs to be done.

MITOCHONDRIAL DNA VARIATION AMONG HARBOUR SEAL AND GREY SEAL POPULATIONS

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We are testing whether we can identify population specific genotypes in phocid seals to investigate natal site fidelity, population structure and colonisation history. Here we report on a study of harbour seals (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) across almost their entire geographic range. Mitochondrial DNA genotypes were characterised by PCR amplification and direct sequencing of region I of the D-loop. 18 genotypes were identified in 72 harbour seals and these partitioned with the current subspecific classification for the species. 3 of the 4 genotypes in European harbour seals were shared among populations. In grey seals, 20 genotypes were identified in 38 individuals, with no types shared between the Western and Eastern Atlantic. 12 genotypes were found in UK populations, with 3 types shared between sites. In both harbour and grey seals, some gene flow (through female dispersal) between populations in Europe is therefore apparent. We are now increasing our sample set and incorporating additional seal populations, e.g. the Baltic.

POPULATION CHARACTERISTICS OF HARBOR SEALS (*PHOCA VITULINA RICHARDSI*) USING PHOTOGRAPHIC IDENTIFICATION AT YERBA BUENA ISLAND, SAN FRANCISCO BAY, CALIFORNIA

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The population of harbor seals in San Francisco Bay (SF Bay) is thought to be declining, however no comprehensive surveys have been performed since the 1970s. The purpose of my study was to determine the number and site fidelity of harbor seals hauling out at Yerba Buena Island (YBI) in central SF Bay using photographic identification. From December 1990 to December 1992, individuals were identified using scars, flipper and/or radio tags, and unusual pelage patterns. YBI appears to be primarily a male haul-out site, even during the breeding season. The preliminary analysis shows higher abundances in the winter, possibly due to the nearby winter Pacific herring run (*Clupea harengus pallasii*.). Abundances are lowest in the summer and fall. Many of the photo-IDed individuals were only seen once, but it is yet to be determined if this was because of recognition problems or low-site fidelity. Most one-time sightings were in the winter and spring. Many of the animals seen more than once have high-site fidelity. Resightings also seem to be seasonally dependent, with most occurring in late fall, winter, and spring. It is possible that YBI serves as a seasonal stop-over for males during the intensive feeding and breeding seasons.

CONSERVATION OF IRRAWADDY DOLPHINS (Orcaella brevirostris) IN LAO PDR AND CAMBODIA

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Irrawaddy dolphins (Orcaella brevirostris) are present in the Mekong River in Vietnam, Cambodia and Lao PDR. A group of 20-30 dolphins were observed from 1991-1993 in an approximately 2 km long stretch of river along the Lao PDR-Cambodian border. Villagers in the area suggest that the number of dolphins has declined in recent years. Several sources of anthropogenic mortality were identified, including gillnet entanglement, explosives used for fishing by Cambodians, shooting by soldiers and villagers, and bombing raids during the Vietnam war. Tissue samples were collected from recovered carcasses for genetic and toxicological analysis.

REPRODUCTIVE RATES OF HUMPBACK WHALES ALONG THE CALIFORNIA-OREGON COAST

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Reproductive rates of humpback whales have been examined for a number populations. Previously, information of the California-Oregon-Washington feeding population was limited to research a single area around the Gulf of the Farallones/Cordell Bank. In 1991 and 1992, we sampled many regions along the California and Oregon coasts from May to November. Calves comprised 4.0% and 2.3% of the humpback whales seen in 1991 (n=659) and 1992 (n=1039), respectively. The proportion of calf sightings in 1991 and 1992 varied significantly by region (chi-square, $p<0.01$) and ranged between 0.9 and 5.1%. It is not clear whether this difference is due to age-class segregation or merely reflects seasonal differences in calf numbers and effort. Through photo-identification, the proportion of cows with calves comprised 3.3-4.7% of the 212 whales identified in 1991 and 2.6-3.1% of the 351 whales in 1992. Thirty-six reproductive females have identified since 1986. Although they were frequently resighted, only four have been seen with calves in multiple years. The proportion of calves seen within this feeding aggregation appears to be low in contrast to the birth rates of 4-13% determined in other regions.

THE DIVING BEHAVIOUR AND SEASONAL MIGRATION OF ADULT HOODED SEALS

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Movements and diving patterns of 8 male and 6 female hooded seals (*Cystophora cristata*) were determined using satellite-linked time-depth recorders. Seals were captured on the whelping patch in the southern Gulf of St. Lawrence, Canada between 1991-93 and tracked for an average of 97 days between mid March and late June. Uplinks were obtained on over 95% of the days. Females left the whelping patch immediately after weaning their pups while males remained in the area until the end of March. After leaving the whelping patch, animals moved northward into the Laurentian Channel where they remained for 1-2 months diving to depths of ≤530m. Most dives lasted 10-25 minutes. Twelve of 14 seals left the Gulf through Cabot Strait, travelled along the south coast of Newfoundland and moved northward along the Continental Shelf, diving for extended periods (15-25+ min.) to 100-500m. Two males exited through the Strait of Belle Isle. All but 1 seal migrated eastward across the Labrador Sea to the moulting patch off East Greenland, undertaking repeated dives of 100-300m. While at sea, animals were submerged over 80% of the time.

WHALES AND SCALES: CONSIDERATIONS OF SPATIAL AND TEMPORAL SCALES IN BALEEN WHALE DISTRIBUTION

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Spatial distribution of whales on feeding grounds is non-random at some scales of observation and random at others. The results of a 1992 NMML cruise in the Gulf of Alaska suggested that fin and humpback whale distribution was patchy at scales greater than 10 sq nmi and random at smaller scales. The observed distribution was similar to previous surveys suggesting long-term site-fidelity by populations to specific feeding areas. The number of whales at a given location was variable between surveys, suggesting temporal patchiness. The persistence time of a patch of whales is probably a function of distribution of prey in the area and can be measured directly or estimated using random walk and diffusion models. Spatial and temporal distribution determines within and between patch dynamics. This can affect surveys since the time necessary to survey between patches may be similar to whale movement between patches. The scales of spatial and temporal distribution are likely to be a source of variation in population assessments since there may be a higher density of whales within patches than between them. This also has implications for patterns of resource utilization where certain areas may have a high density of prey within a limited area allowing for a relatively high feeding rate to be associated with it.

The person who thinks about doing
something is usually passed by
someone doing it.

REVIEW OF THE MARINE MAMMAL MARKING, TAGGING, AND REPORTING PROGRAM 1989-1992

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Through a 1981 amendment to the Marine Mammal Protection Act of 1972, the U.S. Fish and Wildlife Service (USFWS) established the Marking Tagging and Reporting Program (MTRP) to monitor the Alaskan Native harvest of polar bear, sea otter, and walrus. In villages where a USFWS office existed, employees were designated taggers; otherwise, local Native residents were hired and trained. Alaskan Natives that harvest these species are required by law to present specified parts to their local tagger within 30 days of the kill.

Sea otters were tagged in 26 villages with an average of 223 otters per year from 1989-1991. As a result of a 1991 legal decision concerning use of sea otter skins, the harvest increased to 631 otters in 1992. Polar bears were tagged in 13 villages, with an average of 97 per year. The number of polar bears tagged decreased each year, from 132 in 1988/89, to 58 in 1991/92. Walrus tusks were tagged in 49 villages with an average of 1483 per year. The walrus harvest was concentrated in 3 villages that accounted for 75% of the total harvest. Harvest estimates from the MTRP are an important component in the management of these species in Alaska.

PATTERNS OF DISPERSAL OF HUMPBACK WHALES, *MEGAPTERA NOVAEANGLIAE*, IN THE WESTERN NORTH ATLANTIC.

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Photographic identification records from the North Atlantic Humpback Whale Catalog were analyzed to determine trends in dispersal of individual humpback whales, *Megaptera novaeangliae*. Movement between feeding aggregations in the North Atlantic and within the Gulf of Maine feeding aggregation were analyzed.

Dispersal patterns were found to be highly variable. The highest incidence of resighting occurred between adjacent feeding areas. Resighting rates declined with distance between sites, though resightings did occur between widely separated feeding aggregations. Whales from four areas (Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, and Greenland) were identified in each of the other areas.

Within the Gulf of Maine, resighting patterns varied significantly with gender. A higher percentage of females than males from each region were sighted in more than one region of the Gulf.

PROGESTERONE LEVELS AND REPRODUCTIVE STATUS OF BELUGA (DELPHINAPTERUS LEUCAS) FROM THE CANADIAN ARCTIC.

Stewart, R. E. A. Department of Fisheries and Oceans, 501 University Crescent, Winnipeg, Manitoba, R3T 2N6 Canada.

I examined progesterone and ovaries
Of beluga from three arctic localities.
  High progesterone in the cetus
  Clearly indicated a fetus
In a manner predictable, almost always.

Progesterone level in serum
Indicated which whale was a mum.
  In nanograms per ml,
  Under 3 says she will,
Over 3 indicates she has done.

Females in a reproductive class
Were examined for ovary mass.
  Hormone concentration
  Showed weak correlation
In only pregnant females, alas

Fetal samples spanned only thirty days,
A period too short in many ways.
  But fetal mass was quite low
  Up to nearly a kilo,
Variable for early gestation days.

PINEAL FUNCTION IN NEWBORN HARP SEALS

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The pineal gland of seals appear to differ from that of other mammals. It is very large and much larger and seemingly more active in newborn than in adult seals. We have recorded the daily rhythms of pineal and plasma concentrations of melatonin in newborn harp seal pups. In addition we have recorded the daily rhythms of thyroxin and triiodothyronine, to test for a possible functional relationship between the pineal and thyroid gland in these animals. Both glands were highly active and showed marked, daily rhythms of hormone secretion, i.e. plasma levels of melatonin and thyroxin were higher during the night than during the day, while triiodothyronine was highest during the day. The high, daytime pineal activity indicate that the newborn seal pineal is not inhibited by light, possibly due to a low sensitivity to daylight. The findings also support the notion of a possible causal connection between the pineal and thyroid gland, which may be of importance for thermoregulatory functions in these animals during their first, critical days of life.

PROGRESS REPORT: STUDY OF HECTOR'S DOLPHIN MOVEMENT PATTERNS USING RADIO TAGS AND SIGHTINGS FROM LAND.

Stone, G.S., Yoshinaga, A., Brown, J., Hutt, A., Rutledge, M., Hickling, G., and Goodyear, J.
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This is a 1993 progress report for research conducted on New Zealand's Hector's dolphin (*Cephalorhynchus hectori*) in the vicinity of Bank's Peninsula. The objective of this program was to initiate research on the daily movement patterns of Hector's dolphin. Methods included cliff-top observations of dolphin swimming directions and suction-cup radio tagging. Preliminary results show that dolphin swimming directions observed from cliff-tops were correlated with time of day, indicating an off-shore trend in the evening and an in-shore trend in the morning. Further research is needed to confirm and interpret these results in an ecological context for this species. Three dolphins were successfully tagged with suction cup radio tags as they rode in the bow-wave of the research boat; the animals were not detained and two of the animals continued to ride the bow-wave after being tagged. Radio signals from one tagged dolphin were received up to 12 hours after tagging. These "taggings" were done as trials and this was the first time suction-cup radio tags have been used on free-swimming dolphins.

USE OF A LOW COST REMOTELY OPERATED VEHICLE TO STUDY FEEDING BEHAVIOR AND PREY DISTRIBUTION OF HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) IN ALASKAN WATERS

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A tethered low cost remotely operated vehicle (LCROV) equipped with still and video cameras was used to observe and identify whale prey and determine prey depth of feeding humpback whales. In December 1991, 16 dives were conducted over 7 days from an anchored vessel. The use of the LCROV was monitored from a nearby skiff in case of whale entanglement. In addition, 79 groups of whales were approached and 93 whales were photographed for individual identification. Herring (*Clupea harengus*) was identified as target prey in three different dive areas. Herring schools were observed at depths of up to 111m. Whale diving behaviors were correlated to prey depth. Prey was patchy in two of the dive sites and layered in the third. Prey encounters with the LCROV were sporadic over time while the vehicle was at any specific depth. The LCROV was occasionally able to identify prey patches observed with hydroacoustic equipment. The LCROV did not interfere with whale feeding behavior as whales continued to feed close to the vessel before, during and after all dives. Whales were observed on an echosounder during one dive and no whale was observed underwater with the LCROV cameras. The potential for using an underwater monitoring system in marine mammal research will be dependent on the species, study objectives and type of equipment available. This study was supported by the West Coast National Undersea Research Center, Fairbanks, AK and conducted under National Marine Fisheries Service scientific research permit #571.

DETECTING PREGNANCY FROM THE AIR

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Migrating gray whales, *Eschrichtius robustus*, were studied near Monterey Bay, California, in late December of 1989 and 1990 to evaluate aerial photogrammetry as a benign method for distinguishing late pregnant from non-pregnant south-bound adults; and, ultimately, to assess life history parameters important to population dynamics, including pregnancy rates, magnitudes of fat stores during fasting, and rates of mass transfer from mother to calf.

Still photographic images were shot vertically from altitudes between 275 and 325 m through a camera port with a hand-held Pentax 645 camera equipped with a calibrated 208 mm lens and vertical bubble level. Whale image dimensions measured from the developed negatives included rostrum tip to point of maximum girth, width at point of maximum girth, and rostrum tip to fluke edge. Actual girth and length dimensions were calculated from these image measurements and altitude, camera lens focal length, and magnifier enlargement.

Characterization of pregnancy is based on a discriminant function analysis of girth, length, and reproductive state data of 180 southbound gray whales taken off central California, 1959 -1969. Photographic images of 40 whales of adult size (>11 m) obtained during the two flights were of sufficient quality for body length measures, and 27 of these also yielded measures of maximum body width. Thirteen of 27 (48%) were classified, using the derived discriminant factor, as pregnant and 7 (26%) as not pregnant. The remaining 7 (26%) exhibited intermediate probabilities of being classified as either pregnant or not pregnant. These results suggest that: 1) most late pregnant females can be distinguished from other adults on the basis of photometric measures alone, and 2) late pregnant females continue to dominate the early phase of the south migration of gray whales.

This work was partially supported Cetacean Society International.

PUPPING PHENOLOGY AND DISTURBANCE OF HARBOR SEALS (PHOCA VITULINA RICHARDSI) IN THE NORTHERN SAN JUAN ISLANDS, WASHINGTON

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Surveys were conducted during 1991 and 1992 pupping seasons at two primary haul-out sites to determine pupping trends, and quantify activities causing disturbance to harbor seals.

Pupping began the second week in June and the maximum number of pups ashore occurred during the last week in July and first week in August. Puffin Island had a significantly ($p < 0.001$) greater percentage of pups ($x = 16.58$, $se = 1.07$) than Clements Reef ($x = 2.63$, $se = 0.30$, $t = 24.09$). Human harassment (≥ 1 seal entering the water) of seals on haul-out sites occurred between 48% and 89% of the days surveyed. Powerboats were the primary source of disturbance (53% in 1991 and 67% in 1992), with "sealwatching" being the primary activity leading to harassment (73% in 1991 and 78% in 1992). Other important disturbance sources included kayaks, bald eagles (Haliaeetus leucocephalus), and unknown causes.

ECOLOGY OF SUBSISTENCE HARVESTED BELUGA WHALES AT POINT LAY, ALASKA

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Beluga whales were harvested annually from 1987 to 1993 by eskimo hunters at the village of Point Lay, Alaska. Measurements and tissue samples were collected to gain a better understanding of the ecology of northwest Alaska beluga whales. A total of 275 belugas was caught. The number of whales caught per year ranged from 16 in 1989 to 77 in 1993. The hunters choose mainly white animals, therefore the sample is biased toward larger and older animals. The median length of males was 400 cm with a range of 240 cm to 485 cm (n=144) and 344 cm for females with a range of 209 cm to 410 cm (n=114). The percentage of males in the catch for all years is 56% although the sex ratio seems to fluctuate by year (77% males in 1987 to 19% in 1989). This suggests a segregation of the sexes during late June and early July when the hunting occurs. The pregnancy rate for all mature females for all years was 61.4% and ranged from 41.7% in 1988 to 77.3% in 1991. Growth rates are similar to what has been observed for other belugas in Alaska.

IMPAIRMENT OF SPECIFIC IMMUNE RESPONSES IN HARBOUR SEALS (Phoca vitulina) FEEDING ON FISH FROM POLLUTED WATERS

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In a semi-field prospective study, two groups of eleven juvenile harbour seals were fed fish from different marine regions. One group was fed on herring from the heavily polluted Baltic Sea, while the other group was fed on herring originating from the less contaminated Atlantic Ocean. The estimated daily intake of Ah-receptor binding organochlorines was approximately seven times higher in the first group. Longitudinal changes in parameters of specific immune function were studied over a two year period. Although the general health status of all 22 animals appeared good during the experimental period, lymphocyte responsiveness proved to be impaired. Proliferative responses of peripheral blood mononuclear cells after stimulation with the T cell mitogens Con A, PHA and PWM, or after antigen-specific stimulation with rabies virus antigen or tetanus toxoid, were significantly reduced in the seals feeding on Baltic Sea herring. This is the first demonstration of impaired immune function in marine mammals caused by chronic exposure to contaminants accumulated through the food chain.

CHARACTERIZING A MIGRATORY POPULATION OF COASTAL BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN VIRGINIA

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Following the mass mortality of bottlenose dolphins, *Tursiops truncatus*, along the U.S. east coast in 1987-88, it was clear that little was known of their population status in this region. In 1989, the Virginia Marine Science Museum (VMSM) initiated Operation Dolphin, a long-term study of Virginia's coastal bottlenose dolphins. Primary components of the study include: 1. development and curation of a dolphin photo-identification catalog for Virginia 2. analysis of the structure, movements, distribution, and size of this transient dolphin population, and 3. examination and analysis of stranded dolphins in the state. Currently the Virginia catalog contains more than 50 individuals which have been identified. Results from the photo-ID study indicate both annual and within season migrations of bottlenose dolphins through Virginia coastal waters. Resights include one dolphin present during all 5 years of the study and more than 6 individuals present in multiple years. Observational and stranding data support the hypothesis that calving and nursery grounds are located primarily around the Chesapeake Bay Mouth. Shore-based and boat observations along Virginia's ocean coast have provided a broad picture of the distribution of the dolphin population and generated population size estimates of over 300 dolphins. Operation Dolphin provides preliminary data for the long-term study of the migratory population of coastal bottlenose dolphins found off the coast of Virginia.

MIGRATORY MOVEMENTS OF POLAR BEARS IN NORTHERN BAFFIN BAY

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The movements of 38 adult female polar bears were monitored every 5 days with satellite radio collars. The movements recorded were not simple overlapping home ranges as has been observed in other areas. Rather the movements indicated a migration from summer retreats on islands in western Baffin Bay to feeding areas off Greenland during the ice covered season. The population appears to be shared between Greenland and Canada, and is hunted by aboriginal peoples from both nations.

We speculate the reasons for the observed migration are mainly due to high ringed seal densities which are associated with the west Greenland current. The North Water Polynya appears to form a partial barrier to polar bear movements in northern Baffin Bay, which has the effect of reducing exchange with polar bears in the Lancaster Sound, Jones Sound, and Kane Basin area. The migration is aided by a counter-clockwise current which carries the bears west and south to summering areas in the fjords and coasts of Bylot and Baffin Island in during breakup.

Effective management of this shared population will require some sort of cooperative agreement between Canada and Greenland on how the sustained yield should be shared. Current estimates suggest a harvest of more than 100 polar bears per year from this population. The movement data suggests that previous estimates of population numbers be viewed with caution because the mark-recapture effort was mainly restricted to coastal areas in Canada during spring. This study will be extended to include an inventory of this stock when the telemetry phase has been completed.

THE EFFECT OF DISTURBANCE ON HARBOR SEAL HAUL OUT IN BOLINAS LAGOON, CALIFORNIA

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This study looked at the types and effects of human disturbances upon harbor seals hauled out at Bolinas Lagoon, California. This area is subject to a large amount of recreational activity, including boating, fishing and hiking. Disturbances and seal responses were recorded during daylight hours on weekends in autumn 1992. This study found the most common disturbance was small non-power boats such as canoes and kayaks (56%), followed by power boats (16%), hikers and dogs (13%), unidentified (12%), and road noise (3%). Power boats elicited the greatest flushing rate response (73%), followed by non-power boats (68%), and humans and dogs (33%). The distance of the disturbance to the seal haul out showed that 68% of the events which led to seals flushing were within 100 meters, while 13% were between 100-200 meters, and 19% at distances greater than 200 meters. The documentation of seal response to human disturbance in Bolinas Lagoon could be applied to the development of conservation and management plans for other seal haul outs in areas subject to high recreational use.

POPULATION VIABILITY ANALYSIS OF A MODEL BASED ON STELLER SEA LIONS

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Population viability analysis (PVA) assesses the probability of extinction in a given time period. PVA is proposed as criteria to classify species according to extinction risk. To investigate the precision and bias in PVA and to assess the two classification schemes proposed for the IUCN red data book, a model was created based on the recovery plan for Steller sea lions. 30 simulations were run of the model which incorporated demographic and environmental stochasticity. These simulations generate the true distribution of extinction times. Data of the quantity and quality actually available for the species was sampled from the simulations. A PVA, where parameters had to be estimated, was then performed on each sample data set. The PVA simulations generate the estimated distribution of extinction times. Growth rates were positively biased resulting in percent extinct in 100 years ranging from 12 to 89% (mean = 50%) estimated from the PVA compared to 64 to 82% (mean = 76%) from the model. The Mace & Lande classification scheme placed 28 PVA simulations as endangered and 2 as vulnerable all based on PVA while the IUCN scheme placed all 30 as endangered all based on estimated trends in abundance.

OCCURRENCE, DISTRIBUTION AND PREDATION BEHAVIOR OF KILLER WHALES (*ORCINUS ORCA*) IN MONTEREY BAY, CALIFORNIA

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Killer whale (*Orcinus orca*) sightings (n=409) were collected since 1913 in Monterey Bay, California. Consistent and detailed records during 1984 to1992 (n=243) were analyzed to determine whale occurrence patterns, distribution, and behavior. The study area (1060 km^2) was divided into 4 km^2 grids for analysis. Sightings were concentrated nearshore (67% in less than 200 m), close to the shelfbreak (54% within -2 to +2 km), and in high relief grids (62%). Whales were sighted in all months, but were more abundant from September through May (2.9±2.2 sightings/mo.) with fewer sightings from June through August (0.8±0.9 sightings/mo). An average of 27.4±9.7 pods were observed per year, with a mean group size of 4.8±5.1 (max=60). Adult males were 0.4±0.2 of all individuals. Killer whales attacked gray whales (n=29), blue whale (n=1), Dall's porpoise (n=1), California sea lions (n=14), harbor seals (n=2), N. elephant seals (n=2), blue shark (n=1), and rhinoceros auklets (n=1). Killer whales were observed either in association with or pursuing fin whales, Pacific white-sided and Risso's dolphins. Narratives describing pursuits, attacks, and consumption along with hunting strategy for several of these prey items are presented.

LOW-FREQUENCY HEARING IN A PACIFIC WHITE-SIDED DOLPHIN

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There is concern that wild cetaceans may be adversely effected by human-generated noise in the world's oceans. Noise from commercial or military vessels, oil/gas production and transport are of particular concern because of their low frequency content and high amplitudes. Hearing in a variety of cetaceans has been examined, but usually not at low frequencies. An adult female, Pacific White-Sided Dolphin (Lagenorhynchus obliquidens) housed at the Shedd Aquarium has been trained for broadband audiometric testing, with emphasis on frequencies below 2 kHz. The dolphin stations in an underwater hoop about 4 meters from an underwater transducer. The dolphin reports hearing a 2-second test tone using a go/no-go response. Care is taken to measure ambient background sound pressure levels prior to each test session so that any changes in response level by the dolphin can be interpreted. From these data, a hearing response curve plotted against background level and critical ratios can be calculated.

COMPARATIVE ACTIVITY AND MOVEMENT PATTERNS OF HARBOUR AND GREY SEALS FROM THE DORNOCH FIRTH, N.E. SCOTLAND.

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Grey and harbour seals are sympatric throughout much of their range but little is known of the extent of overlap in the two species' foraging areas and feeding behaviours.

We compared the activity and movements of both species in the Dornoch Firth, NE Scotland. Activity patterns and at-sea locations were recorded using both VHF and satellite-link telemetry. Regular haul-out counts provided data on terrestrial distribution and abundance.

Harbour seals were present at local haul-out sites throughout the year. Foraging areas of many of the 21 VHF-tagged harbour seals overlapped considerably and were all within 60km of haul-out sites. In contrast, grey seals were abundant only in the non-breeding season. During this period 4 of the 5 tagged grey seals exhibited extensive movements (>125km) to other breeding areas, although one also used the foraging areas frequented by local harbour seals.

These data suggest that these harbour seals forage around their breeding sites throughout the year. Grey seal feeding movements appear to be more extensive, leading to spatial overlap between grey seals from different breeding areas.

REPRODUCTIVE BEHAVIOURAL TACTICS OF MALE GREY SEALS BREEDING ON LANDFAST ICE

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The behaviour of male grey seals (Halichoerus grypus) breeding on landfast ice at Amet Island, Nova Scotia, was studied during January 1992 and 1993. Scan sampling and ad-libitum observation techniques were used to record behaviour. Serial mass records were also collected for males, to provide data on energy expenditure. The degree of polygyny, measured as the ratio of females to reproductively active males, was lower than the estimates of the degree of polygyny that have calculated for land-breeding grey seal colonies in the eastern Atlantic, but similar to Sable Island in the western Atlantic. The average time budget of the ice-breeding males was comparable to that of land-breeding males. However, there was much variation in behaviour among individual males, parially in response to differences in ice-topography and female behaviour, and male time budgets also showed changes over the season. Reproductive effort (measured as the estimated percent of body mass lost over the season) and success in agonistic interactions with other males were both related to male reproductive success.

COMPARISON OF DIVE BEHAVIOUR AND CARDIAC RESPONSES OF FREE RANGING HARBOUR AND GREY SEALS.

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We used acoustic and VHF telemetry to examine interactions between natural diving behaviour and physiology in grey (Halichoerus grypus) and harbour seals (Phoca vitulina). We monitored dive depth, swim speed and heart rate (HR) as seals travelled, foraged and rested.

The tracked animals of both species were apparently benthic foragers. Harbour seal foraging and travelling dives were short (mean=3.34min; sd=1.90;max=13.9) and seals swam at 0.75-2 $m.s^{-1}$ throughout. Swim speed was not related to dive duration. Grey seal dives were also generally short (mean 4.25min.,sd.3.7) and active, but 6% exceeded 10 mins. Swim speed decreased as a function of dive duration, in long dives grey seals generally restrict swimming to ascent/descent.

HR fell as the seals dived and bradycardia was maintained throughout all dives in both species. Diving HR declined as a function of dive duration in both species but the rate of decline was greater in grey seals. HR fell to very low levels (<4 bpm) in long, inactive dives.

Harbour seals were studied during the breeding season and early stages of moult. The lack of long dives and extreme dive responses may be indicative of a generally heightened metabolism at that time. The reduced swimming activity in long dives by grey seals could indicate that extreme bradycardia may inhibit swimming activity. We suggest that observed differences in physiological dive responses between species may be largely explained by accounting for differences in behaviour and/or physiological state.

PHYSIOLOGICAL RESPONSES OF NORTHERN ELEPHANT SEAL PUPS DURING VOLUNTARY DIVING IN THE LABORATORY

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I studied the diving physiology of 12 fasting northern elephant seal pups, *Mirounga angustirostris*, during voluntary dives in the laboratory by measuring their rates of oxygen consumption ($\dot{V}O_2$) with an open-circuit respirometry system. I measured heart rates of six pups visually and with telemetry. Blood samples were collected from six pups using a catheter placed in the extradural vein and then analyzed for hematocrit (Hct), hemoglobin concentration (Hb) and lactic acid concentration (LA). Older pups (3-4 months old) exhibited more pronounced physiological responses to diving than younger pups (<3.0 months old) including increased dive durations, Hct and Hb, and lower $\dot{V}O_2$ and heart rate. For all animals studied, $\dot{V}O_2$ declined as age ($r^2 = .67$), dive duration ($r^2 = .76$) and percentage of time spent underwater ($r^2 = .66$) increased. Heart rate declined as dive duration ($r^2 = .72$) increased and $\dot{V}O_2$ ($r^2 = .62$) decreased. Hct and Hb, and therefore oxygen storage capacity, were elevated by 25% over resting levels during bouts of serial diving, whereas LA remained unchanged. The transient changes in blood oxygen capacity, heart rate and $\dot{V}O_2$ allow elephant seal pups to maintain aerobic metabolism during diving. This prevents the production of lactic acid that would otherwise increase the time necessary to recover from a dive at the surface. The development of these physiological responses to diving are important in preparing pups for the first foraging trip to sea.

A COMPARISON OF ECGs TAKEN FROM SELECTED CETACEANS

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Few studies have examined the electro-cardiogram (ECG) of cetaceans. This paper reviews data collected by a new electrocardiographic recorder and electrode system developed for cetaceans. Results are presented for three species - three fishing gear entrapped and one stranded humpback whale (*Megaptera noveangliae*), a stranded blue whale (*Balaenoptera musculus*), and a restrained wild harbour porpoise (*Phocoena phocoena*). For all species studied PQRST complexes can be generally identified within the ECG waveform. Heart rates measured (using peak to peak R wave intervals) vary from 12 - 40 bpm in the mysticete recordings, to a mean rate of approximately 170 bpm for the odontocete. In one instance - the humpback - measured heart rate was highly variable and appeared to correlate with dive sequences, suggesting the presence of a diving reflex, a phenomenon previously unreported in mysticetes. The use of heart rate as a behavioural measure in cetaceans is discussed with reference to the above results.

BETWEEN-YEAR AND SEASONAL VARIATIONS IN HARBOUR SEAL DIET COMPOSITION IN THE MORAY FIRTH, N.E. SCOTLAND.

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In order to assess the impact of seals upon their prey stocks, it is important to understand the extent of variations in diet composition. Seasonal and regional variations have been well documented, but few studies have investigated whether these variations remain consistent between years. This study aimed to assess the extent of annual and seasonal variations in the diet composition of harbour seals Phoca vitulina.

1061 faecal samples were collected at haul-out sites during both winter and summer months between 1989-1992. Analyses of otoliths and cephalopod beaks were used to derive estimates of the importance of each prey species, expressed as a percentage of the total weight ingested.

Over the study period the importance of sandeels decreased. Complimentary increases were seen in the importance of the octopus Eledone cirrhosa in summer, and gadoids in winter. In contrast to previous winters, clupeoids were poorly represented in the diet. Both the annual and seasonal variations in diet appear to be related to variations in prey stock abundance and distribution.

These results indicate that extrapolation of dietary information from a single year or season is unlikely to reflect the full extent of seal prey interactions.

PHOTOIDENTIFICATION AS A TOOL FOR THE STUDY AND CONSERVATION OF FRESH WATER DOLPHINS IN COLOMBIA

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Photoidentification has been used in the Colombian Amazon and Orinoco regions to identify 84 dolphins by notches, pigmentation patterns and malformations. In the Amazon 30 Inia geoffrensis and 34 Sotalia fluviatilis have been identified over two years, while 20 I. g. humboltiana have been identified in the River Arauca since November 1992.

Identified individuals accounted for an estimated 71.4% of the population of I. g. humboltiana along 55 kilometres of the Arauca river, suggesting that this technique can be used as an index to estimate abundance.

Using photoidentification it was possible to establish that 8 I. geoffrensis changed overall colour take from grey to pink as their physical activity increased.

Long distance movements over a short time have also been registred: a female Sotalia with her calf swam about 30 kilometres from a lake in the Colombian Amazon to Peruvian tributary in less then 24 hours. A female I. geoffrensis swam over 50 kilometres along the Arauca river in less then 30 hours. Photoidentification has allowed us to begin the study of habitat use by known individuals and to pinpoint feeding, mating and nursery areas. In zones used for reproductive activities in the Arauca river we have been able to describe mating behavior, in particular for two male I. geoffrensis with malformations of the snout. Each male was seen mating with several female.

Finally, we have found that photoidentification not only provides biological information but can be used to design conservation strategies, concentrating on prioritary zones. As members of local communities learn to recognize photographed individuals, we hope this will encourage the protection of dolphins.

MATE CHOICE IN GREY SEALS AT NORTH RONA?

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Grey seals show no overt signs of active mate choice on breeding rookeries. We examined dispersion and return patterns of individually identified male (n=38) and female (n=85) breeding grey seals with reference to relatedness of pups produced in 3 consecutive breeding seasons on the island of N. Rona, Scotland.

Dispersion patterns of breeding females are consistent and predictable from year to year. Male distribution within the colony is determined mainly by the distribution of females. Individuals of both sexes display fidelity to previous breeding sites; median distance between pupping sites of individual females in successive years was 55m, and 53m in males. Concurrent site fidelity in both sexes in different years may produce full sibling offspring if the same pairs mate successfully.

We estimate the probability of male and female pairs returning to the same site at the same time in successive years as 0.16-0.20, or 16-20% full sibs if previous pairs mate successfully. However, DNA fingerprinting and microsatellite analysis indicate that 30% of pups tested are full sibs. This disparity could be a result of mate choice, probably by negative selection, as we have cases of full sibs from females which were not faithful to their previous pupping sites.

MOVEMENTS, DAILY ACTIVITY PATTERNS, DIVE BEHAVIORS, AND FOOD HABITS OF HARBOR SEALS (PHOCA VITULINA RICHARDSI) IN SAN FRANCISCO BAY, CALIFORNIA, U.S.A.

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Thirty-nine harbor seals (12 males, 27 females) were captured from February 1990 to February 1992 in South San Francisco Bay, California. Head-mounted radio transmitters were attached to study movements, daily activity patterns, dive behaviors, and food habits. Radio-tagged seals used a mean 2 haul-out sites (SE = 0.2, range 1-7). Nine seals moved to the outer California coast at least once, ranging north to Pt. Reyes Headlands and south to Pillar Point. Harbor seal movements were within the entire length of the bay from Alviso Slough to Corte Madera Marsh. Seals spent a significantly greater proportion of time diving at night compared to day, and hauled-out more during day than night ($Q = 4.3$, $p < 0.001$; $Q = 4.5$, $p < 0.001$, respectively). The proportion of time spent diving and hauled-out was unrelated to tidal height, harbor seal age or sex, or time of year. Mean dive times were 0.5 (SD = 0.3) to 3.3 (SD = 1.3) min. Fourteen species of fish, and 1 species of cephalopod were identified from 215 fecal samples collected in San Francisco and San Pablo Bays. Of these species, 5 constituted > 93% of the estimated dietary mass. An introduced species, yellowfin goby (Acanthogobius flavimanus), constituted > 54% of the total number of prey items found.

MOTHER - PUP INTERACTIONS OF HARBOR SEALS NEAR MONTEREY BAY, CALIFORNIA DURING 1992

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Diel observations were conducted during the 1991-1992 pupping season at South Fanshell Beach, Monterey Bay California to examine duration and frequency of suckling sessions during lactation.

Maximum counts of mother-pup pairs, lone pups, and total animals accompanied continuous scan sampling of suckling sessions. Suckling session duration, suckling frequency, and daily duration of suckling sessions were calculated for diurnal and nocturnal hours. Mean number of pups increased and female numbers decreased at night, presumably females were feeding at sea. During 184 hours of continuous scan sampling 636 suckling sessions were observed. No statistical difference was found between diurnal ($x = 295.83$ s, $SE = 233.13$ s) and nocturnal hourly duration ($x = 309.15$ s, $SE = 216.24$ s) of suckling durations ($t = 0.472$, $p > 0.05$). Mean frequency of suckling sessions was significantly greater for diurnal periods ($0.51\ h^{-1}$, $SE = 0.28^{-1}$) compared with nocturnal periods ($0.23\ h^{-1}$, $SE = 0.19^{-1}$; $z = 3.35$, $p < 0.05$). Overall suckling session frequency was $0.37\ h^{-1}$ while daily suckling duration was 0.74 h/ 24 h.

The lactation behavior exhibited was similar to otariids. Beliefs that harbor seal pups must remain in close proximity to females during lactation may be an artifact of previous sampling solely during daylight hours.

RECENT STRANDINGS OF SPERM WHALES IN THE GULF OF CALIFORNIA, MEXICO.

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The southwest cost of the Gulf of California is the region of México where most cetacean strandings have been recorded.

The sperm whales, *Physeter macrocephalus*, are regular visitants of the Gulf of California. Here we report two single and one mass strandings from the southeast cost of the Gulf of California during the last two years. 1) On February, 1992, a carcass of a 8.5 m young animal was found at the beach of Los Frailes. 2) On January 23, 1993, a 16.0 m male of 38-43 years old was sighted alive but apparently unhealthy in the Bay of Pichilingue, and two days later, it was found dead at the beach of El Mogote in La Paz Bay. 3) From June 4, to July 11, 1993, a pod of 18 sperm whales was sighted in the southern and shallower area of La Paz Bay. The animals apparently were healthy, but for some unknown reason they did not leave the area. On July 11 they appear stranded on the banks near the water front of La Paz, City. The pod was composed for 9 females (8-11 m) three young males (8-11 m) and six animals of unknown gender (8-11 m). There were no calves or bulls. After two days of effort for to rescue them, three animals dead (two 10.75 m. males, and a 10.0 m female), and the others apparently left the bay of la Paz.

These strandings represent the 4th and 5th single strandings and the 6th mass stranding of sperm whales in the Gulf of California.

A summary of Sperm whale strandings and sightings recorded within the Gulf of California is provided with comments on the higher frequency of sightings of this species during the last two years.

SEASONALITY OF REPRODUCTION IN BOTTLENOSE DOLPHINS

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We examined the seasonality of reproduction in captive and wild bottlenose dolphins, *Tursiops truncatus*. Information was requested on the birth dates of calves, origin of breeding females and facility conditions from 27 captive breeding colonies, ranging in latitude from 21°30' N to 61°30' N. We received responses from 19 facilities, describing 146 captive births to 79 females. These detailed responses, supplemented with data from 317 animals in the *Tursiops* Census Database, were used to determine if there is a relationship between birth date and latitude. Mean birth date ranged from March 15 to August 2 in colonies with more than 5 captive births. The timing of birth varied with latitude; with one exception, facilities at higher latitudes demonstrated earlier mean birth dates (r^2 = 0.64) and less variation in the timing of birth (r^2 = 0.33). Little information exists on reproductive seasonality of wild bottlenose dolphins, but well-studied populations at similar latitudes in Florida and Texas exhibit different calving peaks. Factors such as water temperature and variation in food base will be incorporated into our analysis to further examine the genetic and environmental influences on timing of birth.

TOWARD A GENERAL MODEL OF SEA OTTER-SHELLFISHERY INTERACTIONS

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The conventional view of sea otter-shellfishery relations is spatial incompatibility. This view drives ongoing political initiatives to limit numbers or range of sea otters in US waters. Sea otters are efficient predators of several prey species taken by shellfisheries. However, data gathered in the 1980s off California indicate the oversimplicity of the conventional view. There are several examples. Pismo clam numbers have increased despite the presence of sea otters since 1979. Local populations of red abalones persist at high density in the presence of sea otters. Translocated sea otters have had no effect to date on shellfish populations in the translocation zone.

I propose a situation matrix of four dimensions. Sea otter population status (3 categories), habitat quality (2 categories), prey recruitment frequency (2 categories), and prey refuge availability (2 categories) are used to predict effects of sea otters on local shellfisheries. I suggest that nearly two-thirds of the twenty-four possible situations favor at least intermittently productive shellfish populations. Fishery and conservation interests and regulatory agencies must assimilate the complex nature of sea otter-shellfishery interactions in development of management plans for sea otters.

PRELIMINARY STUDY OF CONTAMINANT LEVELS IN BLOOD AND MILK OF BOTTLENOSE DOLPHINS *(Tursiops truncatus)* ON THE WEST COAST OF FLORIDA

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Organochlorines (OCs) such as PCBs, DDT, and other pesticides are persistent environmental pollutants which have been linked to mass strandings of Atlantic bottlenose dolphins, reproductive disorders, and induce vitamin A and thyroid hormone deficiencies in mammals. Previous studies involving stranded or netted animals have left many unanswered questions due to bias in sample collection.

Since 1970, the life history, behavior, and ranging patterns for a population of bottlenose dolphins near Sarasota, FL, have been studied. Individuals from this population are sampled twice yearly in February and June, for blood, milk and other parameters. This research provides a unique opportunity to obtain blood and milk samples from animals of which the natural and reproductive histories are known. The objective of this preliminary study is to first determine what the contaminant levels are for a healthy population. The mean levels of p,p' DDE were found to be 1503 µg/kg lipid in milk (n=3), and 2000 µg/kg lipid in serum (n=2). The mean sum of 28 PCBs was 3100 µg/kg lipid in milk and 4200 µg/kg lipid in serum. These baseline values will serve not only as a means of comparison for stranded or sick animals, but also as a precursor to a study of bioaccumulation and transfer rates of OCs. Seven matched plasma and milk samples will be analyzed in the Fall of 1993 to determine if a correlation exists between contaminant levels. If a relationship is proven we can implement a long-term chemical ecotoxicological study to monitor the health of the Sarasota population. Our work will be integrated with other on-going studies which include basic blood chemistries, hormone and vitamin levels, immunology, age determination, metal analysis and metabolism.

SINGING AND ESCORTING: DO HUMPBACK MALES GET THEIR OATS?

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Recent progress in molecular biology has uncovered several powerful new genetic tools to investigate for population structure. Microsatellites are highly polymorphic genetic markers useful for characterizing individuals within a population and, when a sufficient number of loci are screened, to assign paternity.

To investigate the social organization of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters 13 microsatellite loci were cloned. In the last five breeding seasons over 500 sloughed skin samples have been collected of which 150 have so far been typed for 9 loci. Sampled animals include adult females, calves, males and a few subadults. The males were singers, escorts, or challengers. Samples were also obtained from members of active groups, thought to be males competing for access to a female.

Preliminary results show a high degree of genetic homogeneity among the mother-calf pairs. Interestingly, individuals carrying rare alleles are invariably adult males. Since males and females appear genetically different, our result suggest that they come from different breeding stocks. However, since calves share none of these rare alleles, the males we have sampled appear not to be representative of the calves' fathers.

Each of the new loci was tested on other 25 cetaceans, from 9 families. 93% produced PCR products of which 81.4% polymorphic.

LEGISLATIVE MEASURES FAIL TO PROTECT SMALL CETACEANS IN PERU

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To alleviate high mortality of small cetaceans in the Peruvian artisanal fishery, the Ministry of Fisheries outlawed all takes and trade in cetacean meat since November 1990. UNEP/WDCS commissioned a survey in order to assess the efficiency of this ban. Four ports were monitored regularly in the period August 1991- June 1993. At Pucusana, high levels of catches persisted, however fishermen butchered cetaceans in their boats, and landed meat clandestinely, which impeded quantification. At Ancón, 709 dolphins and porpoises were landed in a period of 84 days, 480 cetaceans were recorded in 82 days at Cerro Azul and 216 cetaceans in 38 days at the Chimbote artisanal terminal (excluding other local wharves). Preliminary estimates of takes per annum are 2,144 (SE 281) for Cerro Azul and 3,095 (SE 364) for Ancón. A minimum catch of 2,000 specimens p.a. is more than likely at Chimbote. At least occasional cetacean landings were documented at 12 other Peruvian ports. The compound species composition was 48.1% *Lagenorhynchus obscurus*, 38.1% *Delphinus delphis*, 11.0% *Phocoena spinipinnis* and 2.9% *Tursiops truncatus*, with a few specimens of other species, eg. *Balaenoptera acutorostrata* and *Ziphius cavirostris*. Most animals were killed in drift or set gillnets or were harpooned. Landings of live dolphins are particularly pervasive at Chimbote, where common and bottlenose dolphins typically are caught by the industrial purse-seine fleet for anchovies and sardines.

Enforcement of the ban is mostly hampered by the difficulty to discriminate between true incidental and directed kills, by ubiquitous structural corruption and poverty. Provincial consumption of cetacean meat remained relatively low, while there are signs that the availability of high-priced 'muchame' (dried dolphin meat) in Lima augmented. This situation does nothing to improve the alimentary intake of low-income Peruvians.

NEW DATA ON THE BIOLOGY OF THE BOLTTLENOSE DOLPHIN, *Tursiops truncatus*, AND THE ATLANTIC HUMPBACK DOLPHIN, *Sousa teuszii*, (DELPHINIDAE, CETACEA) ON THE COAST OF MAURITANIA (WESTERN AFRICA).

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Between January 1990 and July 993, individuals and schools of the species *Tursiops truncatus and Sousa teuszii* have been surveyed from the mauritanian beach between the localities of Nouakchott and Nouamghar and from traditional latine sail boats used by Imraguen fishermen on the Parc National du Banc d'Arguin located on the North of the precedent area.

Aerial surveys with a single engine airplane has been conducted for the census of populations.

Strandings has been studied : Fresh body and skulls measurements, reproductive tracts analysis, stomach contents and teeth collections have been performed. Results are presented for both species.

Photo-identification has been made for several individuals of both species and an assay on the possible social behaviors and movements is expressed. 8 mm video sequences are presented.

Sightings and strandings are presented on a detailed map and an estimation of the total population for each coastal species is of about 50 (fifty) for *Sousa teuszii* and about 200 (two hundred) for *Tursiops truncatus*.

THE DOLPHINS OF THE UPPER AMAZON RIVER: A PROGRESS REPORT

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In March 1993 we began a study of the population biology, ecology and behavior of dolphins (bufeo colorado, Inia geoffrensis, and tucuxi, Sotalia fluviatilis) along the ca 120 km of the Amazon River bordering Colombia and Perú, and on a small portion of the Brazilian-Peruvian border. We surveyed the main river, several smaller rivers, channels and lakes during 417 hours as of 10 July (observations will continue until December). Of these, 248 hours were spent in direct observations of dolphins. Over 3,000 photographs have been taken to identify individuals showing scars, nicks and particular color patterns (data are being analized). Four main areas of concentration have been identified and about 25 individuals of each species have been estimated per area: (1) Río Loretoyacu and Tarapoto-El Correo lake system, (2) Río Atacuari, (3) Lago Caballo Cocha, and (4) Ramón Castilla. Of a total of 593 sightings, 248 were of Inia, 191 of Sotalia, and in 154 both species were present. Taking all sightings and all habitats combined, the proportion of Inia vs. Sotalia is almost 1:1. Most groups of Inia (76%, n=774) and Sotalia (76%, n=454) were found in waters less than 150 m from the nearest shore; group size ranged between 1 and 6 individuals (84% of all groups were of 1-2) for Inia and between 1 and 20 individuals (76% were of 1-4) for Sotalia. Loose aggregations of up to 23 Inia and ca 50 Sotalia were seen. Eighty-three percent of all groups of Inia and 75% of Sotalia were in water depths of 3-12 m. Both species are commonly found in so-called "white" and "black" waters but, more often, in areas of confluence. Mating and births of Inia were observed. Local fishermen reports indicate that unknown numbers of dolphins of both species are incidentally caught in gillnets.

MORBILLIVIRUS INFECTIONS IN AQUATIC MAMMALS

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Infections with morbilliviruses have caused heavy losses among different populations of aquatic mammals during the last 5 years. Two different morbilliviruses were isolated from disease outbreaks among seals in Europe and Siberia: phocid distemper virus-1 (PDV-1) and phocid distemper virus-2 (PDV-2) respectively. PDV-1 was characterized as a newly identified morbillivirus, most related to canine distemper virus (CDV), whereas PDV-2 most probably is a strain of CDV. Morbilliviruses were also isolated from porpoises - porpoise morbillivirus (PMV) - and dolphins - dolphin morbillivirus (DMV) - which had stranded on the coasts of Europe. PMV and DMV proved to be closely related to, but distinct from 2 ruminant morbilliviruses, rinderpest virus (RPV) and *peste-des-petits-ruminants* virus (PPRV). Serological surveys carried out among pinniped and cetacean species in the seas of Europe and North America indicated that infections with these newly discovered morbilliviruses or closely related viruses commonly occur among aquatic mammal species.

THE IMPACT OF FISHING GEAR ENTANGLEMENTS ON TWO SUBSTOCKS OF THE WESTERN NORTH ATLANTIC HUMPBACK WHALE, *MEGAPTERA NOVAEANGLIAE*

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Increased use of fishing gear in the marine environment can be detrimental to such animals as cetaceans, particularly through entanglement. Examination of the impact of such mortality on two substocks of the western North Atlantic humpback whale, *Megaptera novaeangliae*, indicates that when entanglement losses are added to natural mortality estimates and subtracted from birth rate estimates, there may be an annual mortality as high as 5.4 percent to the Newfoundland population and 4.8 percent to the Gulf of Maine population. We conclude that more effective entanglement reporting and assisting systems are needed in the Gulf of Maine and increased efforts are needed to decrease entanglements, entanglement mortalities and damages to fishing gear. Monitoring of the size of humpback populations needs to continue given their particular vulnerability to coastal fishing and the potential impacts of entanglement mortality.

INVESTIGATIONS ON THE IMPACTS FROM THE EXXON VALDEZ OIL SPILL ON HUMPBACK WHALES (*Megaptera novaeangliae*) IN PRINCE WILLIAM SOUND

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In 1989, 11 million gallons of crude oil from the *Exxon Valdez* drifted through southwestern Prince William Sound where feeding humpback whales aggregate each summer. Photo-identification of individual whale flukes was used to investigate abundance, distribution patterns and annual calving rates during the summers of 1989 and 1990. Results were compared to baseline data collected prior to the oil spill to investigate potential impacts.

Corresponding with the increased survey effort after the oil spill, higher numbers of whales were documented (n= 35:1988, 59:1989, 66:1990). Whales were not observed feeding directly in oil however the path of the spill passed through primary feeding areas. Analysis of the distribution of humpbacks within the study area indicated reduced numbers of whales in lower Knight Island Passage during July of 1989 when oil spill cleanup activity was high in that area. In addition, 9 (15%) of the whales photo-identified in 1989, including two of only four females with calves seen that year, were seen only at Hinchinbrook Entrance and never came into the Sound. Five of those whales, including one of the females with a calf, have been documented feeding in Prince William Sound other years, and may have avoided the area in 1989 due to the oil spill or associated activities.

Calving rates are highly variable and it was not possible to distinguish a significant difference after the spill. The annual calving rate in 1989 (6.3%), was below the mean for other years. (9.5%, se = 1.2, range:3.6-14.6%) In 1990, the annual calving rate (10.8%) was above mean.

Far reaching impacts to the ecosystem in Prince William Sound, including impacts to important humpback prey species such as pacific herring, were documented during the Exxon Valdez Oil Spill Symposium in Anchorage Alaska 1993 . Sub-lethal injuries to humpbacks including diseases or reproductive failure resulting from inhalation, or ingestion of oil or chemicals applied after the spill will be difficult to detect.

THE POPULATION STATUS OF THE NORTHEASTERN OFFSHORE SPOTTED DOLPHIN AND THE EASTERN SPINNER DOLPHIN

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Since 1959, dolphins have been killed in the tuna purse-seine fishery in the eastern tropical Pacific, with the majority being either from the northeastern stock of offshore spotted dolphin (*Stenella attenuata*) or from the eastern stock of spinner dolphin (*Stenella longirostris orientalis*). The U.S. National Marine Fisheries Service (NMFS) recently proposed listing both stocks as depleted under the U.S. Marine Mammal Protection Act (MMPA). Five NMFS research vessel surveys between 1986-1990 provided data used to calculate the current abundance of each stock, resulting in estimates of 730,900 for the northeastern spotted and 631,800 for the eastern spinner. The population status of both stocks was assessed by back-calculating initial population size in 1959 from those current estimates of abundance. The eastern spinner dolphin was estimated to be at 44% of its level in 1959, while the northeastern spotted dolphin was found to be at 22% of its level in 1959. Both stocks were found to be significantly below the maximum net productivity level, indicating that they are both depleted as defined by the MMPA. To improve upon the back-calculation technique, a new method was developed using Bayesian statistics to simultaneously estimate the rate of increase of a dolphin population and its initial population size, by fitting a population model to available time-series of abundance data. A preliminary analysis resulted in an estimated rate of increase of less than 3% annually for the eastern spinner dolphin, with the current population level estimated to be at 31% of its initial population size in 1959. The eastern spinner dolphin has been formally listed as depleted by the NMFS, while a final ruling on the northeastern offshore spotted dolphin is expected soon.

A SURVEY OF PCB LEVELS IN PORPOISES FROM AROUND THE UK COAST

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Marine mammals, as top predators, are particularly at risk from PCB contaminants which are thought to lower the immune response and have been shown to cause reproductive failure in seals. Blubber samples from 98 porpoises *Phocoena phocoena* obtained from both by-catches and strandings around the UK coast were assayed for 25 different PCB congeners. The effects of a number of factors including sex, age, geographical location and cause of death on the levels of the PCBs were investigated.

Age was determined by counting the growth rings in teeth. The locations were West Scotland, East Scotland (including Shetland), East England, English Channel and the Irish Sea. Post mortems were performed on most of the animals to determine those which died by acute means (eg drowning) and those which died by chronic means (eg starvation, disease).

The levels of PCB found showed great variation between individuals ranging from 0.1 to 139.8 mg/kg lipid and males tended to have higher levels than females. The levels in males, but not females, also tended to increase with age. Geographical differences were found but no significant differences related to cause of death were seen. PCB congener patterns showed little variation among individuals, the main congeners measured being #153, #138, #180, #187 and #149.

WHISTLES OF BOTTLENOSE DOLPHINS: COMPARISONS BETWEEN POPULATIONS

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Bottlenose dolphin whistle structure was compared between populations, by spectral and statistical analyses. Differences in whistle structure were greater between non-adjacent than adjacent areas. Animals from adjacent areas may influence each others' whistles by mimicry, but may also have similar whistles due to periodic change of individuals across areas. Whistle differences among groups within and between adjacent areas were small. Dolphins in non-adjacent areas presumably developed unique acoustic characteristics due to geographic isolation. This characteristic of different whistle structures could potentially be used to distinguish between different populations. The frequencies of the major energy of dolphin whistles were higher than the major frequencies of background noise, and a specific acoustical niche relative to environment may be hypothesized.

HABITAT UTILIZATION BY BOTTLENOSE DOLPHINS IN SARASOTA BAY, FLORIDA

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Sarasota Bay is home to a resident community of approximately 100 bottlenose dolphins (*Tursiops truncatus*). The purpose of this project is to understand how these dolphins utilize different habitat types within their Sarasota Bay home range. We identified 6 habitat types based on water depth, bottom topography, and other physical and biological factors. Point sample data on dolphin activity and habitat utilization were collected from 11 focal dolphins during 1 June to 28 August 1992 and 18 May to 13 July 1993, over a total of 405 observation hours, involving 1597 3-minute point samples. Behavioral data were collected in conjunction with doubly-labelled water energetics experiments involving the focal dolphins. Of 7 categories of activities considered, the 3 primary activities we have observed are feeding, travelling, and milling. Chi square analysis demonstrated a significant difference in the frequency of activities in 5 of the 6 habitat types ($P<0.001$). Feeding was observed most frequently in shallow water. The majority of travelling was seen in channels, while milling was predominantly observed in shallow and open bay waters. We are continuing to refine our habitat definitions and are monitoring differences in habitat use patterns by the focal dolphins on a seasonal basis. Activity data will be integrated with metabolic rate data to produce time-energy budgets.

MEASUREMENT OF THE FLORIDA MANATEE (*TRICHECHUS MANATUS LATIROSTRIS*) BLUBBER THICKNESS AT VARIOUS BODY SITES.

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Blubber thickness was measured in Florida manatees to test the hypothesis that blubber thickness can be used as an index of body condition. Two techniques were employed. In the first technique, blubber samples were taken from 22 fresh, salvaged carcasses that were retrieved from Florida waters and included 6 females and 16 males ranging from 194 cm to 330 cm in length. Blubber was collected at dorsal midline, 10 cm off dorsal midline, and 10 cm off ventral midline at the level of the external auditory meatus, axilla, umbilicus, anus, and peduncle. In the second technique, a portable ultrasound device (calibrated against a clinical diagnostic ultrasound) was used to measure dorsal blubber thickness in 34 live manatees to supplement the baseline blubber-thickness database and to examine variability in blubber thickness at different anatomical sites on the same manatee and on the same anatomical site on different manatees. In 10 of the 34 animals, measurements of blubber were repeated over several months.

An anatomical map of manatee blubber distribution has been initiated. Initial examination of carcass blubber distribution showed two layers of blubber underlying the ventral surfaces anterior to the peduncle and one blubber layer underlying the dorsal surfaces. Blubber thickness in the carcasses varied between body sites (range of means = 4.6-15.4 mm). The dorsal location of greatest variability was 10 cm off the umbilical midline (CV = 0.66). The dorsal area of least variability was the peduncle at dorsal midline (CV = 0.29). These data suggest that blubber thickness shows considerable promise as an index for evaluating body condition and the umbilical location at 10 cm from midline is the most likely target for measurement.

MITOCHONDRIAL DNA ANALYSIS OF THE HARBOUR PORPOISE, *PHOCOENA PHOCOENA* (L.), IN NORTH AMERICAN WATERS: POPULATION STRUCTURE, ZOOGEOGRAPHY AND TAXONOMY

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To better understand the population structure, historic zoogeography and taxonomic status of the harbour porpoises, *Phocoena phocoena* (L.), of North American waters, mitochondrial DNA (mtDNA) from 204 individuals were analyzed (9 restriction endonucleases were used in this survey).

MtDNA diversity was high especially within the Western North Atlantic population; in total, 51 different haplotypes were found. At least three possible explanations exist for this observed diversity: 1) high mutation rate in harbour porpoise mtDNA; 2) the Western North Atlantic is a large or expanding population; and 3) immigration frequently occurs.

MtDNA of Eastern North Pacific animals were distinct from those of the Western North Atlantic; moreover, the restriction patterns produced by any one of four endonucleases alone was sufficient to discriminate these two populations. However, genetic discreteness among proposed subpopulations within the Western North Atlantic was not supported.

The mean divergence between haplotypes of the Eastern North Pacific and Western North Atlantic suggests that, on average, the haplotypes last shared a common ancestor during the middle to late Pliocene. Any post-Pliocene exchanges through the Arctic were not sufficient to obscure mtDNA differentiation. Furthermore, exchange via the Central American Seaway cannot be rejected, although the Arctic is still the more probable route.

The present study together with the results of Rosel (1992, Ph.D. thesis) suggests that the taxonomic status of harbour porpoises need revisions. There are two possible options: 1) retain *P. p. relicta* (Black Sea - Sea of Azov) and reinstate subspecies *P. p. vomerina* (North Pacific) and *P. p. phocoena* (North Atlantic); or 2) eliminate *P. p. relicta* and reduce it to subpopulation status.

THE REHABILITATION AND RELEASE OF BOTTLENOSE DOLPHINS FROM ATLANTIS MARINE PARK, WESTERN AUSTRALIA

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The objective of this project was to release a social group of 9 captive bottlenose dolphins, *Tursiops truncatus*, into the local wild population. The group had been used as exhibition animals at Atlantis Marine Park, Western Australia until the closure of the park in August 1990. At time of release the group was comprised of 3 adult males, 2 adult females, 3 juvenile females and one newborn calf. The adults had been captured near the release site in 1981 and the juvenile animals were born in captivity in 1989.

The rehabilitation program occurred in several stages. The first took place at the marine park and included a reduction in training and other interactions with people, the incorporation of live fish into the dolphins' diet and the placement of an identifiable freeze-branded number onto each dorsal fin. A survey of the local wild population was initiated, focusing on group dynamics and identification of individuals.

The second stage involved transporting the dolphins to a sea pen in the local marina. Here the animals were trained to follow a boat and to respond to an underwater recall signal. Several weeks prior to release, radio tracking devices were attached to the dorsal fins of the adult animals.

The dolphins were released from the sea pen on 13 January 1992 and were tracked and followed as often as possible during the next 2 months. Radio tag failures and the increasing range of the animals precluded their being found after this time.

Three dolphins failed to integrate into the wild and were returned to the sea pen, while the newborn calf disappeared and is presumed dead. The fate of the other five animals is largely unknown, although a number of unconfirmed sightings have been reported. One significant finding from this project is that the proper assessment of the ability of released animals to integrate into the wild is highly dependant on the use of effective tracking devices.

THE IMPACT OF THE M.V. BRAER OILSPILL ON THE SEALS OF SHETLAND

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The sub-lethal and lethal impact of the oil spill from the tanker M.V. BRAER off the south coast of Shetland on 5 January, 1993, on grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seal populations was assessed. Analysis of faecal samples collected in the vicinity of the oil spill indicated that sandeels (*Ammodytes spp*) and other benthic fish species were the most important items in the diet of grey seals, whereas mackerel and whiting were important for common seals. These results will be combined with estimates of hydrocarbon levels in different species to calculate the amount of oil seals may have ingested.

Detailed behavioural and symptomatic observations were carried out on animals hauled-out in the area of gross contamination over a period of four weeks following the spill. Up to 27% of grey seals hauled-out showed symptoms of respiratory distress. This was significantly higher than the proportion observed at an unaffected site in Shetland. Harbour seals on the southeast coast of Mainland (Shetland) did not show respiratory symptoms.

Results of a thermal image survey of harbour seals in August 1993 will be compared with those from a similar survey conducted in 1991 to determine whether there has been any unusual mortality or redistribution. Survival of grey seal females will be estimated using photo-identification techniques.

SPERM WHALE TRACKING UNDERWATER AND AT THE SURFACE

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Two (15 and 11 m) sperm whales tagged with 36 kHz sonar transponder tags in October 1991 and one (12 m) sperm whale tagged with an HF radio tag in April 1993 were tracked in the southeast Caribbean west and south of Dominica Island. The sonar transponder tags provided depth telemetry for detailed observations of dive profiles, and the HF radio tag gave detailed data on whale movements at the surface. Most dives were to depths of 400 to 600 m, with occasional deeper dives, including one of 1185 m and one apparently to 2000 m. Tagged whales were tracked separately and together for periods of 3 to 22 hrs, over tracks of approximately 8.5, 31, 40, and 150 km. Whale movements at the surface on different days averaged from 0.68 to 0.82 m/s, with dive descent rates from 0.82 to 1.13 m/s, ascent rates from 0.74 to 1.16 m/s, and horizontal movement during dives from 0.76 to 1.29 m/s. Dives of 400 m or more lasted from 18 min to 1 hr and 13 min, with average durations of 33 to 41 min on different days by the same whale. Every sonar track ended because tag signals became obscured at night apparently by dense biological scatterers. The radio track was abandoned when the whale continued to move away from the area needed for other work. The obvious next tag for detailed study of sperm whales is one that combines the sonar and HF radio to provide tracking underwater and at the surface.

A "FLEXIBLE BODY MASS" IN KILLER WHALES

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Groups of foraging predators are traditionally thought of as collections of individuals. In fact, any such group may be better described functionally as a single predator; group mass among social carnivores correlates strongly with prey mass. It follows that social hunters may alter their group size ("flexible body mass") in response to changes in prey mass.

We explored the relationship between group mass and maximum prey mass for lions (*Panthera leo*), wolves (*Canis lupus*), and killer whales (*Orcinus orca*). We found no significant relationship for lions or wolves ($r_{adj.}^2 < 0.01$, $P > 0.5$); there was, however, a highly significant linear relationship for killer whales ($r_{adj.}^2 = 0.95$, $P = 0.00015$).

The nonsignificant results for terrestrial carnivores may be due to factors that affect the foraging success of groups regardless of their mass. Groups employ multiple individuals to detect prey, and can simultaneously attack several targets; a single individual of the same mass would not enjoy such advantages. This would confound a purely mass-based analysis.

Such factors may be less important, however, in pelagic habitats; for example, groups may be no better than individuals at detecting prey in an open environment. Furthermore, the prey of lions and wolves can generally outrun their attackers if alerted early; this does not appear to be true of the killer whale's prey. Prey mass (rather than speed) may therefore be of paramount importance in determining the outcome of a predator-prey encounter involving killer whales. Such factors may explain the (apparently atypical) existence of a "flexible body mass" in this species.

HEART RATE AND OXYGEN CONSUMPTION IN ELEPHANT SEALS DIVING IN THE LABORATORY

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Our aim was to investigate the relationship between heart rate and oxygen consumption ($\dot{V}O_2$), to determine whether heart rate could be used as an indicator of metabolic rate. Six juvenile elephant seals, Mirounga angustirostris, were allowed to dive freely in a metabolic chamber at Long Marine Lab, Santa Cruz, California, while simultaneous measurements of heart rate and $\dot{V}O_2$ were made. The seals spent an average of 74% of the time under water, with a mean dive duration of 6.43 ± 0.6 minutes. Mean $\dot{V}O_2$ during diving was 3.32 ± 0.4 ml/min/kg, a decrease of approximately 26% from resting values. Heart rate during dives was on average 36% lower than resting values, and was independent of dive duration, percent time submerged, or $\dot{V}O_2$. Heart rate while breathing increased slightly with increases in the preceding dive duration, but was not correlated with $\dot{V}O_2$. Mean heart rate, measured during a dive and the following breathing interval, increased with increasing $\dot{V}O_2$, and was inversely correlated with percent time submerged. An inverse relationship was also observed between $\dot{V}O_2$ and percent time submerged. These results are consistent with other studies supporting the hypothesis that diving is not energetically costly, however, preliminary analysis leads to the conclusion that heart rate is not an accurate method for determining metabolic rate in this species.

POLYDACTYLY IN A BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS

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Odontocete thoracic limbs are pentadactylous, a state primitive and common for eutherian mammals. Congenital anomalies are rare. We report one polydactylous bottlenose dolphin, Tursiops truncatus, that had 6 digits on his left flipper and 5 on his right. (This immature male, 2.20 m TL, 7 dentinal GLGs, stranded on the Texas coast of the Gulf of Mexico.) Both flippers had a similar pattern of 6 carpal bones and 5 metacarpals. The phalangeal formula for the normal right flipper was I-0, II-7, III-6, IV-3, V-1. In the left flipper the fourth digit was duplicated and both duplicates articulated with the distal end of metacarpal IV: the abaxial duplicate had 3 phalanges and appeared similar to the right digit IV; the axial duplicate had 4 phalanges, the proximal 2 of which were irregular in outline. The shape of the caudal borders of the flippers were different but flipper lengths and widths were not significantly different from sample means. This congenital defect, which apparently had no adverse affect, was likely due to homeobox and or apical ectodermal ridge dysfunction during embryonic development.

Supported by the Texas Marine Mammal Stranding Network.

SPERM WHALE BEHAVIOR AND PHOTOIDENTIFICATION PRIOR TO A PARTIAL STRANDING IN THE BAY OF LA PAZ, BCS, MEXICO, 1993

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Two sightings are reported and depicted in still and video imagery. Observations are presented from 23 June - 12 July of 18-20 whales prior to 2.12 animals stranding 10-12 July 93. Three activity phase shifts before stranding were noted. The whales remained in 60-200' of water and exhibited relatively invariant activity despite performing 25 events and 7 states of behavior; cyclic behavioral sequences are also presented. Evidence that some feeding may have occurred included a probable foraging pattern, floating squid remains and defecation. Group cohesion and behavioral homogeneity were conspicuous in stationary rafting and mobile gliding, surging and surfacing patterns but diminished with time. Photo-identification data were collected; infrequency of tail exposure shifted emphasis to distinctive marks on dorsal humps and the middorsum regions. A second unrelated sighting occurred in April of 10-12 whales observed for 130 min displaying highly active surface and aerial behavior. Descriptions of numerous events include breaches, tailslapping and waving, spyhopping, mouthing, vertical formation postures, submerged rafting and defecations.

RESPONSES OF MANATEES TO AN APPROACHING BOAT: A PILOT STUDY

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Numerous opinions exist on the ability of manatees to hear approaching boats and take evasive action. In February 1993, we initiated a pilot study to identify manatee responses to an oncoming boat by conducting a series of motorboat passes close to manatees resting near a power plant discharge in St. Petersburg, Florida. A 5.3m boat powered by a 120HP engine, fitted with a propeller guard, was used for the tests. Scientists 180m overhead in Sea World's Airship Shamu established radio contact with the boat crew to direct the boat and record the results using a broadcast-quality, gyrostabilized video camera and tape deck. The boat was maneuvered through manatees at three speeds: 8-12kph, 32kph, and 48kph. The videotape was analyzed to determine: 1) behavioral responses; 2) time/distance differences between the first avoidance response and when the animal would be potentially struck; and 3) time-after-boat passage when animals return to the surface to breathe. During each of the 18 trials analyzed, manatees did not remain on the surface as the boat passed. The most common avoidance behavior was slow submergence as the boat approached at all speeds. Remaining stationary was also common, principally occurring when animals were in shallow water. Less-common behaviors were movement out of the boat's path into deeper or shallower water, diving, bursting, and turning horizontally. Avoidance behaviors were initiated earlier when the boat approached at 8-12kph ($\bar{x} \approx 24$sec) than when it approached at 32kph ($\bar{x} = 11$) and 48kph ($\bar{x} = 6$). Distance to the boat when avoidance began was comparable at all speeds ($\bar{x} = 50$-58m) and did not exceed 100m. Manatees waited longer to resurface following passage of the boat at the two higher speeds. Refinements necessary for a complete study include placement of buoys at 25m intervals, reduction of the observation angle from the airship, use of a variety of boat sizes and engines, and determination of a sound signature for each boat-engine combination.

VARIATIONS IN THE VOCAL REPERTOIRES OF SPERM WHALES (*Physeter macrocephalus*) WITH GEOGRAPHIC AREA AND YEAR

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To gain insight into the functions of sperm whale vocalizations called codas (short, patterned series of clicks), sperm whales were recorded in the Caribbean and the S. Pacific (off Christmas Is., Phoenix Is., Tonga, N.Z., Easter Is., Chile, N. Peru-Ecuador) on 23 different days (N=1,673 codas) in 1992-3. Recordings were also made off the Galapagos Is. in 1985, 1987, and 1989 (N=2,011 codas). Codas formed distinct categories based on their temporal pattern of clicks. Repertoires were compared by examining the proportional use of the different coda types. Caribbean whales had a radically different repertoire from those in the SE (r_S=0.11, p>0.05) and SW Pacific (r_S= -0.04, p>0.05), whereas the SE and SW Pacific repertoires were much more similar (r_S=0.64, p<0.01). Within the Pacific, differences in repertoires between areas were less obvious. The Galapagos repertoire was most similar to nearest-lying Ecuador-N. Peru than any other area in the S. Pacific. There was more similarity between repertoires from the same stable group followed on different days than between different groups in the same area. In the Galapagos, there was more similarity in repertoires between years than between it and any other area in the S. Pacific. Moreover, repertoires from adjacent years (e.g. '85-'87: r_S=0.81, p<0.01) were more similar than those separated by the longest time ('85-'89: r_S=0.50, p<0.05). Thus, codas, which function in social communication, show large-scale geographic variation as well as progressive variations over time.

COMMUNITY STRUCTURE OF BOTTLENOSE DOLPHINS ALONG THE CENTRAL WEST COAST OF FLORIDA

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Research over the last 23 years has shown the existence of a permanent, year-around home range for a community of about 100 bottlenose dolphins residing near Sarasota, Florida. Until recently, information for placing this residency pattern into perspective relative to other bottlenose dolphins was limited to sightings from occasional surveys through adjacent waters. With National Marine Fisheries Service support over the last 6 years we have expanded our systematic photographic identification censuses to include the surrounding waters of Tampa Bay, Charlotte Harbor and the Gulf of Mexico, resulting in a catalog of more than 1,500 dolphins. Repeated sightings of a number of these dolphins over multiple (up to 18) years indicate the existence of a mosaic of overlapping home ranges through the expanded study area. In those regions where year-around survey efforts have been conducted, individuals have been observed throughout the year. As in Sarasota, home range boundaries are not exclusive. While rates of permanent immigration and emigration appear to be low, shorter-term individual movements between communities occur. Both males and females move briefly between communities, though male excursions are more common. Genetic analyses by D.A. Duffield indictate the existence of some interbreeding between communities. The definition of this community structure has important implications for the management and conservation of coastal bottlenose dolphins.

FUNCTIONAL MORPHOLOGY OF BALAENID WHALE TONGUES

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In balaenid whales, as in other mammals, the tongue is a muscular hydrostat that undergoes complex shape and positional changes by contraction, respectively, of intrinsic and extrinsic lingual muscles. Gross and microscopic examination of the tongue, sublingual tissues, and associated oral musculature of fetal, neonatal and adult bowhead (*Balaena mysticetus*) and right (*Eubalaena glacialis*) whales reveals the extent and arrangement of muscle fibers necessary for tongue movements (e.g. elevation, depression, retraction) implicated in feeding and deglutition, notably the ingestion of water-borne prey and its subsequent dislodging from baleen. Fresh, frozen, and preserved specimens were sectioned or dissected. In both species profuse vertical and transverse fibers of the m. lingualis proprius traverse an abundance of adipose tissue (presumably for insulation or seasonal fat storage); the prominent m. genioglossus has several distinct heads. In addition to descriptive myology, analysis involved quantification of relative contributions of intrinsic and extrinsic lingual muscles as proportions of the total tongue mass or cross-sectional area (calculated by digitization of projected photographs); results differ from those of odontocetes and other mysticetes. Innervation, vascularization, and surface structures (e.g. possible tactile or pressure receptors) were investigated with regard to tongue mobility for feeding, thermoregulation, and suckling.

The tongue is commonly ascribed an especially prominent role in balaenid feeding, based on its relatively massive bulk and high position in the oral cavity. The mechanisms by which it assists in prey capture and removal from fine baleen fringes have received particular attention, but since balaenids normally feed in waters with low visibility, proposed functions are purely conjectural, loosely supported by anecdotal evidence yet never directly documented. In the absence of such observations competing hypotheses (involving mechanical contact or hydrodynamic flow) are evaluated by functional inference from anatomical data.

A POPULATION SHIFT OF HUMPBACK WHALES IN THE SOUTHERN GULF OF MAINE: THE ABANDONMENT OF STELLWAGEN BANK.

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Humpback whales (*Megaptera novaeangliae*) have been studied intensively in the southern Gulf of Maine since the late 1970's. In the period 1988-1993, a dramatic decline in the amount of use of Stellwagen Bank, an important habitat through the 1980's, has occurred, especially by adult whales. In 1988, 147 adults (greater than five years in age) were identified on Stellwagen, with an average of 13.5 sighting days per individual (occurrence) and a mean period of 67.9 days between first and last sighting (occupancy period). In the same year, 65 juvenile whales (between one and four years old) had a mean occurrence of 7.3 days, with a mean occupancy period of 47.1 days. By 1992 the trends had gradually reversed - only 84 adults were sighted on the Bank, with a mean occurrence of 7.2 days and mean occupancy period of 32.4 days, while 55 juveniles had a mean occurrence of 19.6 days and mean occupancy period of 53.2 days. This decline continued as of July 1993 (from April to July 1993 virtually no adults, and only a small number of juvenile whales, were sighted on the Bank). Adults in 1992 were first seen later than juveniles, but were last seen at the same time. Many of the adults formerly sighted on Stellwagen were frequently sighted in 1992 on Jeffreys Ledge, 50 miles north of the Bank, feeding on krill and herring. Previous work has shown juvenile humpback whales to use sub-optimal habitat, and fisheries tow data show a sharp decline in sand lance (the major prey on Stellwagen) during the study period. We hypothesize that the adult whales have shifted their feeding locations to take advantage of herring stocks which have recovered from overfishing. Since herring and sand lance are direct competitors, with herring the apparently dominant species, this shift may be long lasting and have important management implications, both for habitat protection and management of whale watching on the east coast.

DIVING BEHAVIOR OF SOUTHERN SEA LIONS IN PATAGONIA

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Diving behavior of three, lactating female southern sea lions, *Otaria byronia*, weighing 121 to 165 kg, was studied at Peninsula Valdes, Argentina. Time-depth recorders recorded a total of 427 h at sea and 6779 dives.

Foraging trips (n=7) lasted from 13 to 78 h; between 53 and 56% of the time was spent diving (n=2 animals). Mean diving depth was 54.4 ± 3.7 m (SD; n=3 animals); maximum depth for each individual was 97, 99 and 112 m, respectively, reflecting ocean depth rather than diving ability. Diving was continuous, with short surface intervals (95% < 4 min); dives were not organized into bouts. Dive depth and frequency did not vary with time of day. Mean dive duration was 2.9 ± 0.6 min (n=3) with a mean maximum time of 5.8 ± 1.5 min. For two of the animals, the number of dives exceeding the estimated aerobic dive limit was 0.7 and 7.0%, respectively. Transit times to potential foraging areas varied from 8 min to 6 h, representing 0.4 to 27% of total time at sea. Duration of deep (>45 m), intermediate (21-45 m) and shallow (<21 m) dives represented 78%, 11% and 11% of the total diving time, respectively. Three types of dive profiles were distinguished: flat-bottomed U-shaped , irregular bottomed U-shaped and V-shaped. The shape of deep dives (93% flat-bottomed U-shaped) and the absence of diurnal variation in diving depth suggest that the sea lions were foraging on benthic species.

DIVING BEHAVIOUR OF HARBOUR PORPOISES, *PHOCOENA PHOCOENA*, IN THE BAY OF FUNDY, CANADA

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Time-depth recorders were deployed on 1 male and 2 female harbour porpoises in the Bay of Fundy, Canada. All recorders were successfully recovered, providing 63 hours of diving data. Dive records revealed that porpoises dove at frequencies that ranged from 15 to 109 dives per hour. Porpoises spent the majority of time making dives in the upper 20 m of the water column, however, all animals dove below 80 m and one animal descended to 152 m. Deeper dives occurred sporadically during both the day and night and no diel shifts in dive pattern were apparent. Most dives lasted less than 60 s and the maximum dive duration was 256 s.

Harbour porpoises exhibited 2 stereotypic dive types. Type 1 dives were characteristically shallow (mean depth 9.3 S.D. 9.2 m), of short duration (23.3 S.D. 20.9 s) and had brief (8.0 S.D. 8.3 s) bottom times. Type 2 dives were deeper (mean depth 36.6 S.D. 20.6 m), of greater duration (107.6 S.D. 32.8 s) and had longer bottom times (42.6 S.D. 20.0 s).

This study provides the first empirical data on the diving behaviour of free-ranging harbour porpoises. Understanding the diving behaviour of these threatened mammals is crucial to the development of effective management strategies to minimize their incidental catches in bottom set gill nets.

COMPARISON OF PHOTOGRAPHIC AND GROUND COUNTS OF STELLER SEA LIONS AT AÑO NUEVO ISLAND

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Aerial photographic and ground surveys of Steller sea lion rookeries were conducted within one day of each other at Año Nuevo Island during the breeding seasons of 1990-1992 to evaluate the effectiveness of these two sampling techniques for monitoring changes in this population. In addition, 3 replicate surveys were conducted during 1992 to estimate the variance associated with each sampling technique. Regressions fit to the $\log_{10}$ of the counts on year for pup and non-pup photo counts and non-pup ground counts revealed significant declining trends of -3.8%, -19.9%, and -15.2%, respectively. No significant trend was detected in the ground counts of pups. Rates of decline determined from counts of non-pups were not significantly different, but both differed from the rate determined from photo counts of pups. Using the coefficients of variation from the replicate surveys and setting $\alpha = 0.05$ and $\beta = 0.10$, we determined that a 4% annual change in numbers of pups or non-pups could be detected with a series of 3 annual photographic surveys. Ground counts of pups were the most variable of the methods, and the minimum annual change detectable was 18%.

WINTER DISTRIBUTION OF CETACEANS AND HUMAN ACTIVITY IN COASTAL WATERS OF THE MID-ATLANTIC STATES

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Anthropogenic interactions are a major cause of marine mammal mortality. However, resource managers have scant information to aid them in determining when and where such interactions are likely to take place. The occurrence of cetaceans and potentially lethal human activity was investigated using line transect survey methodology in coastal waters between Ocean City, MD (38°20'N/75°05'W) and Ocracoke Island, NC (35°04'N/76°00'W) (=258nm), in Jan - Feb 1993. Two species of mysticetes (humpback and finback) and one odontocete (bottlenose dolphin) were observed. All baleen whales (n=15) occurred south of Chesapeake Bay and all bottlenose dolphins (n=151) occurred from Cape Hatteras south. Both trends in occurrence were significant ($P<0.01$). The distribution of bottlenose dolphins correlated significantly with water temperature, on both macro and micro scales ($P<0.05$).

Additional data (e.g., sightings, behavior, photo-identification and biopsy) were collected during directed cruises. A high of 17 humpback and 4 fin whales occurred on a single day. Body size indicated all humpback whales were sexually immature and no baleen whales were behaviorally associated. Apparent foraging behavior was observed.

The dominant human activities were commercial fishing and shipping. Distribution plots indicated substantial interaction potential between: 1) bottlenose dolphins and the gillnet fishery south of Cape Hatteras and 2) commercial / military vessels with humpback and fin whales, at the entrance to Chesapeake Bay. In addition to providing biological information, surveys can provide valuable insights concerning the vulnerability of protected species to human activity.

NON-STEADY SWIMMING INCREASES AEROBIC DIVE DURATION IN BOTTLENOSE DOLPHINS

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Bottlenose dolphins (Tursiops truncatus) use several behavioral strategies (wave-riding, efficient locomotor speeds) to reduce the energetic cost of transit swimming near the water surface. In this study, we examined whether such energetically efficient modes of swimming enable the diving dolphin to conserve oxygen reserves during prolonged submergence. We monitored diving patterns, descent and ascent rates, heart rate, and post-dive lactate production in two adult Pacific bottlenose dolphins (body weight = 182 kg) trained to dive to submerged markers at 60 m and 200 m near Kaneohe Bay, Oahu. The results showed that the freely diving dolphins often moved at speeds outside the predicted range of 1.7 - 2.3 $m.s^{-1}$ that is considered the most cost efficient for transit swimming. Rather than steady swimming, the dolphins spent 75% of the time passively gliding during the final 20 - 25 m of ascents. Comparison of the aerobic costs for steady and non-steady swimming indicate a 19% savings in oxygen stores if gliding sequences are used. Thus, interrupted swimming patterns may allow dolphins to prolong dive duration by increasing locomotor efficiency.

DISTRIBUTION OF POLAR BEARS IN THE SVALBARD AREA

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In the period from 1989 to 1993 59 female polar bears have been instrumented with satellite transmitters in the Svalbard area in order to estimate the distribution range of the population. Several bears have been re-instrumented and individuals have been followed for periods lasting from about one to about 40 months. Home ranges estimated from the minimum convex polygon method range from about 800 to about 250.000 km^2 for females followed for more than 200 days. The bears have shown a very high degree of fidelity to Svalbard. The mean distance from the tagging locality after one year for 27 bears was 95 km. Only one of the females has moved west of Svalbard. Many bears have moved east into the Barents Sea and into Russian area. About 95% of the recorded localities and 95% of the total tracking time have been spent in Norwegian territory. The tagging effort has not been equally spaced over Svalbard. The results indicat, however, that there is a relative descrete population of polar bears in the Svalbard area.

Hormone and serum metabolites of post partum northern elephant seals

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Female northern elephant seals, Mirounga angustirostris, fast completely during lactation losing an average of 40% of initial body mass. Seventeen females were weighed, blood and milk sampled 2-4 days and 22-25 days post partum in 1992 or 1993. Body composition was calculated from blubber thickness determined with an ultrasonic scanner. Serum concentrations of cortisol, glucagon, glucose, lactate, protein, urea nitrogen, free fatty acids (FFA), triglyceride, glycerol, cholesterol, creatinine, electrolytes, and standard enzymes were determined. Serum cortisol, FFA, glycerol and bicarbonate concentrations increased significantly ($P<0.05$) over lactation while glucagon concentration was low and relatively stable. Serum protein, globulin, urea nitrogen, ALT, AST, CPK, and creatinine decreased significantly over lactation with protein and globulin being significantly correlated with body mass ($R = 0.69$, $P=0.001$; $R = 0.72$, $P=0.001$ respectively).

THE SOCIAL STRUCTURE OF A RESIDENT COMMUNITY OF BOTTLENOSE DOLPHINS IN THE MORAY FIRTH, N.E. SCOTLAND.

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Comparative studies of communities experiencing differing environmental conditions can often provide insight into the factors which influence their behaviour. This photo-id study examines the social structure of an isolated resident community of around 100 identified bottlenose dolphins in the Moray Firth. Predation from sharks appears to be rare, water temperatures are low (5.5-12.5°C) and prey species differ from those of other areas.

Dolphins were studied during regular standardised boat surveys in the inner Moray Firth. 91 surveys were conducted between June 1990 and February 1993. School sizes varied between 1 and 46 individuals (mean 6.3). Pair-wise associations between individuals were calculated to a percentage using the "Simple ratio" index of association. The resulting values were generally low indicating that dolphins tended to associate with a large percentage of the individuals in the community. The only high levels of association were observed between females and their calves. In contrast to other studies, closely associated adult male pairs or triplets (alliances) were not found. The food distribution, low abundance of predators, mating system or isolated nature of this community may account for this finding.

USE OF A MILITARY THERMAL SENSOR TO DETERMINE NIGHTTIME TRAVEL RATES OF MIGRATING GRAY WHALES *(Eschrichtius robustus)*

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The determination of the night migration rate of gray whales relative to the rate observed during the day has long been a key concern for estimating population parameters. Extrapolation of whale movements for periods of non-watch contributes significantly to the uncertainty of an abundance estimate. Past studies have used radio tags, starlight scope and infrared night vision technology, and statistical corrections during predawn and late evening watches. Previous night vision experiments suffered from equipment that was not sophisticated enough to detect small faint targets. In light of the military's recent efforts to transfer technology to civilian use, we approached the US Army to see if they had equipment that could allow us to detect the temperature difference between the exhalation of a gray whale and its surrounding environment. They loaned us an AN/TAS-6 passive infrared imaging system designed to detect and display temperature differences of 0.20°C. The instrument was modified to allow the optical display to be recorded on standard video tape. We used the wide field of view which allowed us to record information from the horizon to about 420m away from the sensor. Tests of the system were run in mid January, when peak numbers of gray whales were migrating past our census station near Carmel, California. Preliminary results show that the whale blows were easily detectable, equally visible during the day and at night, and that roughly equal numbers of pods (15 pods per hour) passed during the day and at night. The whales appeared to be moving at the same distance offshore both day and night. With further testing, this new technique may well prove to be an invaluable tool for nighttime observations of marine mammals.

A CHARACTERIZATION OF RIGHT AND FINBACK WHALE HABITAT IN THE LOWER BAY OF FUNDY, CANADA

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Characteristics of right (*Eubalaena glacialis*) and finback (*Balaenoptera physalus*) whale habitat in the lower Bay of Fundy, Canada, were identified by quantifying relationships between 19 environmental variables and the distribution and density of whales within a quadrat system.

Right whales were generally distributed in the deeper areas of the Grand Manan Basin where the bottom topography was relatively flat, the water was stratified and tides were relatively high. The depth-averaged density of copepods (mean = 1139 m^{-3}, mainly *Calanus finmarchicus*) in quadrats with right whales was significantly greater than in other areas. The densities of right whales were positively related to the maximum depth of quadrats and an index of prey abundance from mid-depths on echograms.

Finback whales were distributed in shallow areas with high topographic variation that, with the strong tidal currents, were well-mixed or contained frontal interfaces between mixed and stratified waters. Echograms from these areas indicated high abundances of herring (*Clupea harengus*) and euphausiids. Densities of finbacks were most strongly related to an index of total prey abundance from echograms, followed by variables indicating thermal fronts and high topographic variation.

A COMPARISON OF MOVEMENT PATTERNS OF RADIOTAGGED MANATEES BASED ON SEX AND REPRODUCTIVE STATUS

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Satellite telemetry has provided data on manatee habitat use and movement patterns of manatees. These data are supplemented by frequent field observations by project staff. The Florida Department of Environmental Protection has completed two years of a five-year radiotelemetry study initiated in Tampa Bay in 1991. A total of 29 manatees have been fitted with radiotransmitters and monitored daily from 1 week to 16 months.

There were marked differences in movement patterns of manatees based on reproductive status and similarities in patterns based on sex. A total of 16 manatees, consisting of 2 immature males and 1 immature female (< 270 cm), 7 adult males and 6 females (> 270 cm), were followed for more than three months. Two of the adult females did not have calves, three were accompanied by calves, and one gave birth during the monitoring period.

Analyses of tracking data revealed a similarity of movement patterns among immature manatees and adult females with calves. They all seemed to confine their activity to well-defined ranges limited to the Tampa Bay and Ten Thousand Island areas. In contrast, 7 adults, including females without calves, traveled extensively outside the Tampa Bay area. Three animals traveled north of Tampa Bay as far as the Suwannee River (270 km) and one adult traveled another 64 km farther. Four moved south 170 km to Charlotte Harbor while another adult continued farther south to the Ten Thousand Islands (130 km farther). A pregnant manatee frequently crossed Tampa Bay (17 km) prior to giving birth. Later, she and her calf stayed in specific locations for extended periods, moving up to 48 km to reach these locations. These data suggest that long-distance movements increase with age unless a female is accompanied by her dependent calf (< 225 cm).

CHARACTERISTICS OF HARBOUR SEAL FORAGING TRIPS

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Data on the activity budgets of Harbour seals are needed to assess their energy requirements, but few details are available on their at-sea behaviour. In conjunction with diet and population studies, we aimed to determine feeding areas, duration of feeding trips and dive characteristics for Harbour seals feeding in the Moray Firth, Scotland.

Locations and activity patterns for 42 seals of both sexes and various ages were obtained by VHF radio-telemetry. For a subset of animals, dive data and feeding locations were simultaneously obtained throughout whole foraging trips.

Trips typically lasted 1-5 days. Animals usually travelled quickly and directly to preferred localities within 60km of the haul-out site. Animals remained over restricted areas, diving regularly for most of the time, although some seals spent periods of up to five hours at the surface. Diel changes in surfacing patterns suggested that the most active feeding was by night.

These data illustrate that surfacing patterns can be used to identify different at-sea activities. Future studies aim to extend this information through the use of time-depth recorders.

METABOLISM AND GROWTH OF A NURSING WEST INDIAN MANATEE (*Trichechus manatus*).

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The manatee has been kept in captivity for decades, but relatively little is known about its metabolic requirements. Here we report the first metabolic measurements collected during the nursing period. On September 13, 1991 a male manatee was born at The Living Seas, EPCOT Center. Commencing in November, 1991, body composition, mass, and metabolic rate were determined using doubly-labelled water methodology. Additional trips were made in February, May, August and November, 1992 and March, 1993. During each trip, the calf was given an oral dose of oxygen-18 (0.15 g kg^{-1}) and deuterium (1 g kg^{-1}) and sampled 12h, 3 d and 5-6 d later. Data indicate that the calf initially exhibited a metabolic rate similar to that predicted for an adult mammal of similar mass (1.1 W kg^{-1}), declining during the nursing period to a minimum of 0.35 W kg^{-1} (44% of predicted)(age 340 d) and subsequently rising at weaning to 0.46 W kg^{-1} (61% of predicted)(age 460 d). During this period the calf grew at an average rate of 0.8 kg d^{-1} and varied in body composition from 14% to 40% fat. On average the calf nursed every 43-53 minutes for between 114±24 and 156±30 sec per session. Nursing accounted for 3.4-5.5% of total activity with rest/sleep (17.3-32.8%) and activity (67.0-70.6%) accounting for the balance. Solid food consumption commenced at a low level by age 30 d and became a significant factor by age 330 days. These data correspond with information available for older animals and are consistent with previously described low rates of metabolism for this species.

This research was funded by Walt Disney Imagineering (EPCOT Center) and the Marine Mammal Commission.

A REPORT OF TISSUE CONCENTRATIONS OF SELECTED METALS AND ORGANIC COMPOUNDS FROM MANATEES IN FLORIDA.

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Recently, tissues collected from manatee carcasses were analyzed to determine concentrations of selected metals and pesticides. We analyzed tissues from 65 carcasses recovered from 18 coastal counties in Florida. Five of the carcasses were freshly dead newborn manatees and we analyzed their liver and kidney tissues for metal and organic residues. From the remaining 60 carcasses, we analyzed only liver tissue for metals. Analyses were standard EPA procedures measuring concentrations of 22 metals and 22 pesticides (screen). Metals of particular interest included copper, aluminum, tin, and mercury. Historically, copper has been used extensively in compounds for aquatic weed control and has been found in high concentrations in manatees.

None of these pesticides were found at levels in excess of the standard detectable limits set for each compound in the screen. Mercury concentrations ranged from <0.42-2.39 mg/Kg, tin 1.56-21.17 mg/Kg, aluminum <2.05-847.4 mg/Kg, arsenic 0.27-6.46 mg/Kg, and copper 10.56-516.80 mg/Kg. The other metals were within concentration ranges reported for mammals. Within the range of concentrations of metals, newborn manatees (<150 cm) had the highest concentrations reported. Copper concentrations found in this study were considerably less than values reported ten years ago. It appears that we were not able to detect excessive concentrations of potential toxins. Yet, given our knowledge of potential sources of pollution within Florida's waterways and manatee feeding habitats and extensive movements, these results are intriguing. As yet, there have not been any manatee die-offs attributed to exposure to chemicals. This research leads us to a closer examination of metabolic pathways that may protect manatees from toxins.

SITE FIDELITIES AND BEHAVIOR OF RADIO-TAGGED BOTTLENOSE DOLPHINS OF THE CENTRAL TEXAS COASTLINE

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Between July 9 and 17, 1992, 10 bottlenose dolphins (*Tursiops truncatus*) were fitted with small radio transmitters as part of a larger NMFS-sponsored Catch/Tag/Physiology/Toxin study; in the area of Matagorda Bay, Texas, where a major die-off of dolphins had occurred in Spring 1992. Five males and five females were tagged; 3 females had calves ≤2yrs. old, 2 of these were also pregnant, and 1 female without calf was pregnant. Radio attachment links were designed for radios to fall off after 2 to 8 weeks, variable depending on salinity and temperature. Useful transmission life ranged from 12 to 60 days ($\bar{x}$=32.3±s.d.18.68 days, n=10). All dolphins were visually resighted numerous times during tracking and during 12 months of follow-up studies. Ranges tended to be small, with most dolphins travelling within a core area of 10 to 16 km diameter; and no strongly definable patterns related to time of day, tide, or weather. There was no obvious difference in travel by sex or reproductive status. One adult female without calf appeared to have two widely separated core areas; one near where she was tagged in Matagorda Bay, one over 50 km SW of this area, in San Antonio Bay. All dolphins stayed within the confines of bays, estuaries, and ship channels, with no indication of ever wandering into the adjacent ocean. This gave a clear-cut separation between resident inshore and more transitory offshore dolphins. Surfacing intervals were significantly longer at night ($\bar{x}$=37.5±s.d.34.61 sec, n=193) than in daytime ($\bar{x}$= 23.9±s.d.17.76 sec, n=377; Nonparametric t', p<.01, statistics from subsample of a larger data set), possibly due to decreased activity level at night. Definition of residencies are especially valuable for upcoming comparisons with general health and body toxin loads.

SEASONAL TESTOSTERONE PATTERNS IN FREE-RANGING HARBOR AND NORTHERN ELEPHANT SEALS

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We measured plasma testosterone concentrations in free-ranging male harbor seals and northern elephant seals by radioimmunoassay. Blood samples were collected from adults and subadults during breeding and non-breeding seasons at rookeries in California and Washington state. In harbor seals, we found geographic differences in seasonal testosterone patterns which corresponded with clinal differences in timing of pupping and mating. Testosterone concentrations remained high (>2.5ng/ml; N=11) for several months during the breeding season. In elephant seals, plasma testosterone peaked in late December and early January (9.30ng/ml ± 7.05ng/ml; N=5) and declined to low levels (0.55ng/ml ± 0.77ng/ml; N=6) by early March. Testosterone was undetectable in molting elephant seals in summer. Individual variability in plasma testosterone concentrations during the breeding season was correlated with age and social status in both species.

RESOURCE PARTITIONING BY COMMON DOLPHINS: AN ADAPTATION TO SEASONAL CHANGES IN PREY AVAILABILITY?

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Large 'schools' of common dolphins inhabit the continental shelf area of the south-east coast of southern Africa. Stomach content analyses of 365 stranded and incidentally-captured dolphins indicates two distinct forms of resource partitioning. In summer homogeneous groups inhabit southern, cool temperate waters. In winter, large 'schools' (>200), containing mainly pregnant and lactating females, weaning juveniles and a limited number of males, migrate northwards into warmer tropical waters. Males and lactating and pregnant females feed in a central area, but juveniles appear to be separated from the main feeding activity and form small sub-groups with adolescent or resting female supervisors. Although sardines dominate the diet of all sex and size classes, mature females have a more diverse diet than males, consuming a larger proportion of mid-water fish species.

In summer however, 'schools' are more widespread, as is their prey. Different sex and size classes, within the group, actively selecting specific prey, depending on energetic demands. Lactating females and calves consume squid, while other sex-size groups consume easily-caught, nutrient-rich fish prey.

The seasonal differences of resource partitioning can be attributed to the adaptation of common dolphins to the temporal and spatial fluctuations in the distribution and availability of their prey. During summer, energetic requirements are maintained through available resources. The reliance of lactating females and small calves on squid may be related to the need for prey with a high water content, important for milk production. The winter migrations, and the associated seasonal concentration of prey resources, presents an ideal opportunity for the weaning of calves, the replenishment of energy stores depleted during lactation and the build-up of stores by pregnant females.

PASSIVE LISTENING AND ECHOLOCATION

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A bottlenose dolphin (*Tursiops truncatus*) demonstrated the ability to select the matching object in a 3-choice delayed matching to sample task after listening to another dolphin inspect the sample object via echolocation. During the sample presentation, the listening dolphin was required to grasp a bite plate which held his melon above the water's surface. The listener was thus prevented from echolocating on the sample object, but could listen as a second dolphin examined the sample. After the sample object was removed, the dolphins were required to make selections from separate arrays of choice objects. During an initial test using objects familiar to both dolphins the listener's performance was significantly better than chance. In addition, it was shown that when the inspecting dolphin made an incorrect choice the listener's performance dropped to chance levels. In a second test, designed to control for the presence of arbitrary cues, objects familiar to only one of the dolphins were used. On these trials, the listener's performance was significantly better than chance only when the inspecting dolphin made a correct choice, suggesting that the listener's performance was dependent on the quality of the echolocation signals produced by the inspecting dolphin.

EJACULATION PATTERN OF A BOTTLENOSE DOLPHIN

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In order to gain more understanding of ejaculation in cetaceans, a mature male bottlenose dolphin (*Tursiops truncatus*) (307 cm in body length) was trained to ejaculate in response to a command for semen collection by hand manipulation method. Semen samples (n=132) were collected over a total of 31 sessions of 13 collection days as follows: (1) single session per day until no further ejaculation could occur in spite of effort (3 sessions in May); (2) 2-3 sessions per day up to 4 ejaculations per session (conducted in morning/afternoon or morning/noon/afternoon; a total of 16 sessions in March, April, June, November and December); and (3) 3 sessions per day (morning/noon/afternoon) for 2 consecutive days (12 sessions in April and May). During successive collections, the dolphin ejaculated 9 (2 sessions) or 10 (1 session) times within 20 min. Semen volume peaked in the first ejaculate, but sperm concentration and total sperm count showed peaks in the second or third ejaculate. An identical pattern was observed also in the other two types of collection. The first ejaculates which were mostly translucent (slightly whitish), tended to be of maximum volume (peak range: 7.0-55.0 ml), but contained no sperm or were of low sperm density. The second or third ejaculates were creamy-white in color and peaked in sperm density and total number of sperm (peak range: 1.1-43.9×10^8/ml and 0.7-49.4×10^9/ejaculate). Possible physiological and artificial factors which are responsible for such an ejaculation pattern are proposed.

CONGENER-SPECIFIC ANALYSIS OF PCBS IN BLOOD OF THE HARBOR SEAL *PHOCA VITULINA* FROM SOUTH SAN FRANCISCO BAY, CALIFORNIA

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Polychlorinated biphenyls (PCBs) have been implicated in mammal reproductive effects. However, difficulty in obtaining representative marine mammal tissue samples has limited research in this area. Here we report a technique for quantifying specific PCB congeners in 1-2 ml samples of whole blood, attainable without sacrificing specimens. Blood samples of the harbor seal *Phoca vitulina* collected from south San Francisco Bay in 1991 and 1992 were analyzed for up to 20 PCB congeners by GC/MS Selected Ion Monitoring. In the first set, seven congeners were quantified by both GC/MS and GC/ECD with good agreement. All samples had measurable levels of at least five congeners; wet weight detection limits were 1 ppb or less. Ratios of specific congeners to PCB-153 were in agreement with published values for blubber and blood samples, consistent with the observation that marine mammal PCB profiles appear to be similar worldwide. The mean lipid-normalized PCB sum for the San Francisco Bay seals was about 10 ppm, among the highest of such values reported for marine mammals and similar to levels in seals from the North Sea.

TREATMENT OF A LIVE STRANDED YOUNG RISSO'S DOLPHIN (Grampus griseus)

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On April 24, 1993, a live stranded Risso's dolphin was brought to Sea World of Texas in San Antonio, for medical care. The animal was a 2 to 3 week old female, 132 cm in length and weighed 25 kg. The dolphin arrived in poor condition suffering from multiple lacerations on the left pectoral flipper and both fluke blades, a wound on the midline immediately anterior to the dorsal fin, and a lesion on the caudoventral abdomen. Clinically, the animal had signs of pneumonia and appeared malnourished. A complete physical which included hematology, chemistries, and cultures was performed immediately upon arrival. Antibiotic and antifungal therapy was initiated for the pneumonia and lacerations. A milk formula was provided initially via stomach tube until the dolphin learned to nurse efficiently from a bottle. Purified beluga immunoglobulins were given by intravenous injection to further help protect against infectious agents. Hematology, serum chemistries, and body weight are being monitored routinely to evaluate the animal's progress. As of 15 July 1993, the dolphin was 155 cm in length, weighed 53 kg and appeared in good health.

ANGIOTENISIN II, ARGININE VASOPRESSIN AND ATRIAL NATRIURETIC FACTOR IN HARBOR SEALS, WEDDELL SEALS, AND STELLER SEA LIONS.

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The plasma concentrations of atrial natriuretic peptide (ANP), arginine vasopressin (AVP, the antidiuretic hormone), aldosterone and plasma renin activity increase in response to exercise in an intensity-related fashion. During head-out immersion, the plasma level of ANP increases, while AVP and the renin-angiotensin and aldosterone systems are inhibited. In mammals, angiotensin II (Ang II) and AVP produce constriction of the vascular smooth muscle, while ANP antagonizes such constrictor effect. Therefore, it is possible that these hormones have a role in the control of the changes in heart rate, blood pressure and redistribution of blood flow observed in mammals during exercise and diving. In an attempt to study the possibility that these hormones have a role in the control of physiological changes in heart rate during diving and exercise, I am analyzing heart rate data, as well as the concentrations of ANP, AVP and Ang II in plasma samples from seals during periods of eupnea and apnea. This is a preliminary report, in which baseline concentrations of ANP, AVP and Ang II were determined in plasma samples from harbor seals, Weddell seals, and Steller sea lions.

A COMPARATIVE STUDY OF MOTHER AND INFANT SIGNATURE WHISTLES IN THE ATLANTIC SPOTTED DOLPHIN, STENELLA FRONTALIS.

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Signature whistles of eight wild Atlantic Spotted Dolphins, Stenella frontalis, (four mother/calf pairs), were examined to determine whether similarities exist between the signature whistles of mothers and their offspring. Data was collected while swimming with a population of animals on the Bahama Banks. Through spectrogram analyses each whistle was examined for duration, low frequency, and high frequency. Correlations, comparing the overall contour of the whistles, were also made between mother/calf pairs and between mothers and non-offspring. The results indicate significant similarities in overall contour both within and between pairs. Furthermore, the data indicates significant similarities between mother/calf pairs for the parameters tested. There is also observational data suggesting that mothers and their calves share similar whistle variations which may be found in portions of the whistle other than the more easily measured parameters examined in this study. This data therefore, points to a system of communication having species typical patterning but one that is also subject to individual recognition.

FIN WHALES IN THE MEDITERRANEAN SEA: RESIDENT OR MIGRATORY?

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The fin whale *Balaenoptera physalus*, the only mysticete species commonly found in the Mediterranean Sea, is rather abundant in the northwestern part of the basin during summer; however, its frequency apparently decreases everywhere in winter. Dedicated summer cruises conducted in the Ligurian and Corsican Seas between 1990 and 1993 have demonstrated that in that region the fin whales' presence peaks in July, and decreases progressively during August and September. Whales aggregate there in small groups (mean group size = 1.4), and actively feed on the abundant euphausiid *Meganyctiphanes norvegica*. Young of the year, ranging in length between 10 and 13 m, are frequently observed, often loosely associated with an adult. Eighteen recognizable individuals were re-sighted over a total of 104 identified animals, indicating the existence of a persistent site-fidelity to the summering grounds. The available evidence, corroborated by genetic analyses currently in progress, suggests that fin whales enter the Mediterranean from the Atlantic ocean in spring to feed in the Ligurian and Corsican Seas. The persistence on the feeding grounds during winter of a small part of the population is not unusual among mysticetes, and might be enhanced by the Mediterranean mild winter climate. However, at the present state of knowledge the hypothesis of the existence of a fin whale population permanently resident in the Mediterranean cannot yet be rejected.

IMPACT OF HUMAN ACTIVITIES ON CETACEANS IN SOUTHERN BRAZIL.

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Interactions between human activities and cetaceans have been commonly recorded in the southern coast of the Rio Grande do Sul State (31°18'S-33°45'S). Information was obtained in the period 1992-1993 by beach surveying, monitoring fishing boats and recovering lost data to verify the nature of these interactions. In october 1988, an adult female Bryde's whale, Balaenoptera edeni, and in August 1989, a juvenile male southern right whale, Eubalaena australis, were found washed ashore with ship propeller marks. Other two right whales suffered impact of human activities; the first had the body divided in two, probably by a steel cable from a shipwreck; and the last collided with a fishing boat but did not die. In May 1990, a long finned pilot whale, Globicephala melas, was found dead in a drift net set up for sharks. During October and November 1992, 11 La Plata River dolphin, Pontoporia blainvillei, were accidentally caught by two monitored fishing vessels using gillnets set up for Sciaenidae in waters 16 to 52m deep. These results suggest that the total catch of La Plata River dolphins is much higher and cause for concern due to the presence of about 300 fishing boats operating in the area throughout the year. This cetacean species is eventually used for human consumption and animal ration. In November 1992, a young male dwarf minke whale, Balaenoptera acutorostrata, died entangled in a bottom-set gillnet for sharks in waters 143m deep. A female Blainvillei's beaked whale, Mesoplodon densirostris, was found dead in February 1993 presenting plastic debris in the stomach. In March 1993, an adult bottlenose dolphin, Tursiops truncatus, was seen swimming with a mullet gillnet debris wrapped round the anterior portion of its body.

Captures and collisions were frequent mainly during winter and spring, and considering the intensive traffic of about 2500 ships per year added to the constant fishing activities, make it clear the necessity of a quali-quantitative evaluation of the interactions in order to establish an adequate management policy.

Money may not buy you happiness, but it will buy you a sailboat big enough to sail right on up next to it.
-David Lee Roth

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